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National Supremacy on the Sea— Lessons of the International Yacht Races. W. P. STEPHENS. 1

The Revolt in Cuba: Its Causes and Effects— As Related to the United States. A NATIVE CUBAN. 9

The Canadian Lumber Industry— Its Importance, Vast Extent, and Development. J. S. ROBERTSON. 17

Architectural Students' Work Abroad— Suggestions as to Methods of Study. G. R. PHENÉ SPIERS. 33

Future of the Electric Telegraph— The Possibilities of Mechanical Transmission. P. B. DELANY. 39

The Newhouse Tunnel at Idaho Springs— A Notable Mining Enterprise in the West. ARTHUR LAKES. 49

Mountain Railroads in Mining Regions— Object Lessons in Difficult Engineering. JAS. R. MAXWELL. 61

Future Methods of Sewage Purification— Excellent Results of the Electric System. W. L. HEDENBERG. 76

Underflow as Related to Irrigation— An Important Problem in the Western States. H. V. HINCKLEY. 84

Racial Traits in Machine Designing— Hints for Mechanical Students and Designers. ALBERT WILLIAMS, Jr. 92

Review of the Industrial Press—

With an Index to all the leading articles published currently in the technical journals of the United States and Great Britain.

Architecture & Build'g. . . 101
Civil Engineering. . . . 108
Domestic Engineer'g. . . . 116
Electricity. 121
Industrial Sociology. . . . 130
Comment and Criticism. . 183
Marine Engineering. . . . 137
Mechanical Engineer'g . . 142
Mining and Metallurgy. . . 150
Municipal Engineering. . . 160
Railroading. 166
Scientific Miscellany. . . 175
Books of the Month. 185.

FOR INTRODUCTION TO AUTHORS, SEE PAGE 5.

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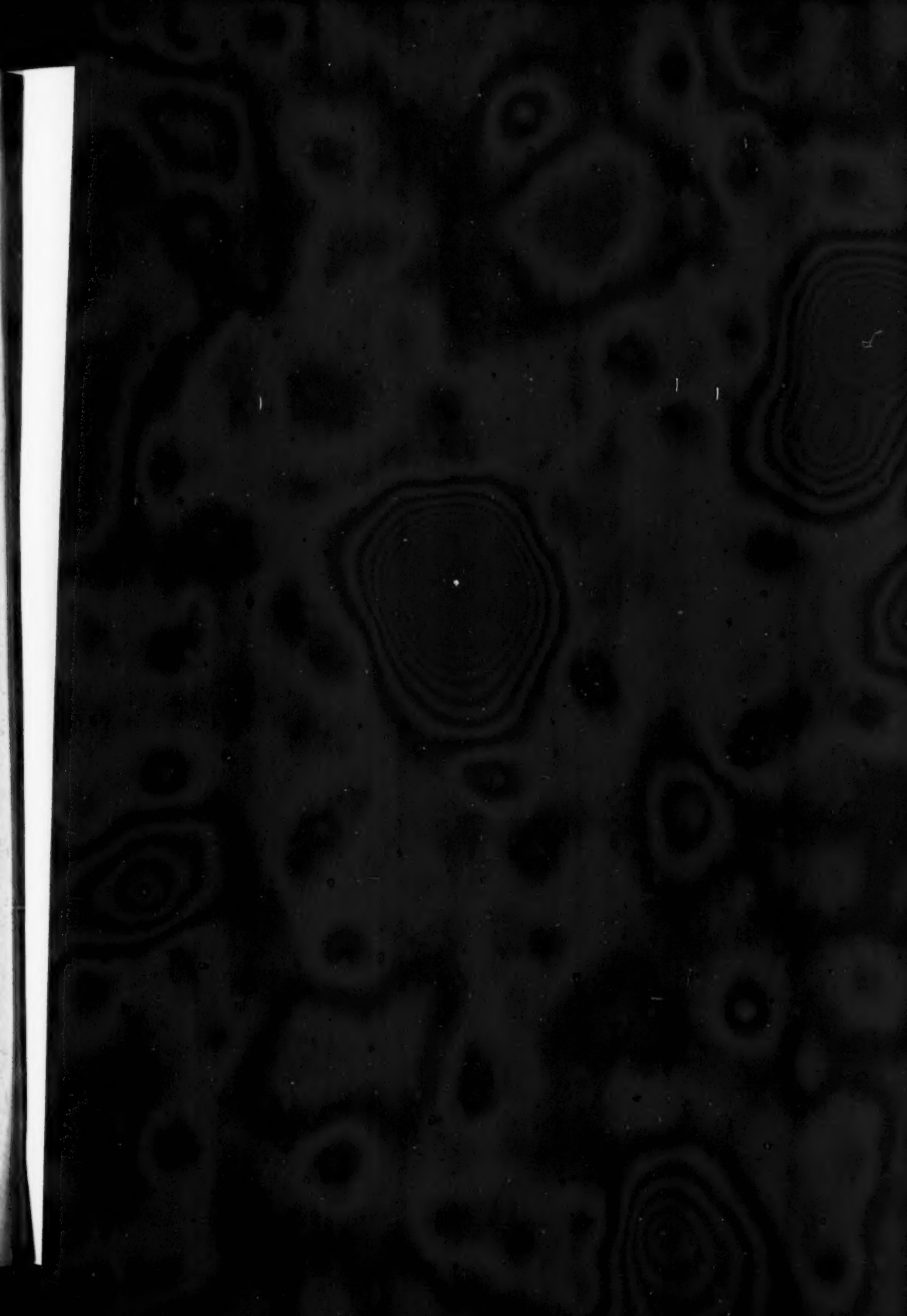

THE

ENGINEERING MAGAZINE

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INTERNATIONAL RACING AND NATIONAL SUPREMACY ON THE SEA.

By W. P. Stephens.

THE great yachting contest of the year is marked by some extreme features which distinguish it from all previous international races; never before has so much money been expended on a pair of racing yachts, of no use whatever save to sail a series of five races. To state the case as plainly as possible, over $250,000 have been expended in a contest for the temporary possession of a piece of silver of little intrinsic value. Had this very large expenditure resulted in the production of two stanch and serviceable yachts, with a useful life of nearly a generation before them, the question might still be asked whether any public good results from such great outlay on articles of mere pleasure and luxury; and it becomes still more pertinent when it is considered that the two great yachts, Defender and Valkyrie, having served their immediate end of racing for the America's Cup, are no longer of any value. Their extreme draft—nearly 20 ft.—makes them useless anywhere but on the open sea, and their general model, construction, and cost of running make them racing machines, not convertible into useful cruisers. To those utilitarians who would answer the question with a prompt and emphatic negative, we would point out some phases of the history of American yachting and of international yacht racing.

When the foundation of what has since become a great system of international racing was laid in 1851 by the schooner yacht America through the winning of the cup offered by the Royal Yacht Squadron (which, by the way, was not a "Queen's cup," as it is so often called), the maritime interests of the United States were near the highest period

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of their prosperity, both technically and commercially. The great clipper ships, the Collins line of trans-Atlantic steamers, and the New York pilot boats brought fame to their builders and money to their owners. The great ship-yards of New York city were turning out some of the finest warships and ocean steamers then afloat, and rivalled the ports of the Eastern States in their ocean clippers and coasting schooners. The interior of the country was as yet undeveloped, the great industries were close to the seaboards or the shores of the lakes, and the heart of the nation was with the sea.

Twenty years later, when the two British schooners, Cambria (1870) and Livonia, (1871) made the first efforts to regain the Cup, now established as a perpetual challenge trophy, there had been a sad change in maritime interests. Many causes—the introduction of the iron ship and the compound engine, the destructive effects of the civil war, and the more profitable field for capital offered by the internal development of the country and the construction of railways—had led the nation almost to forget and neglect the sea. The great shipyards were closed, their owners were dead, the American clipper sailed under a foreign flag, and the navy had dwindled to a few rusty iron monitors, and ironclads converted from the old wooden ships. From the great ocean greyhound down to the smallest tramp fruiter every ocean steamer that entered an American port was under a foreign flag. With peace at home and abroad, and with a magnificent railway system to carry the products of the interior to the seaboard, the nation at large, now covering almost the entire breadth of the continent, was indifferent alike to the need of a protective navy and to the humiliating absence from the seas of the Stars and Stripes. The astounding progress in science and engineering was limited to the land, and everything connected with naval design and marine engineering was neglected.

It was just at the turn of this state of affairs—some 15 years later, when the first movement for the building of a modern navy was under way, and when, through the efforts of a few, the people of the coast at least had begun to awaken to the importance of both a navy and a merchant marine under the American flag—that there came across the ocean a challenge to all American yachts from one of the finest representatives of the British cutter fleet. The development of yachting in America had been almost exclusively in the direction of the shoal centerboard sloop, while in Great Britain it had produced the narrow and deep cutter, such as the challenger, Genesta. Apart from the mere sentimental interest attaching to any contest between the representatives of two great nations, there were many technical points involved, of proportions, model, ballasting, centerboard or keel, sloop or cutter

rig, construction and methods of handling,—points over which a lively controversy had already waged in America,—that added greatly to the interest and excitement of the races.

At first this interest naturally was confined to yachtsmen and the people of the coast; but, through that great medium, the press, the country at large was informed, first, of the fact that America and England were again engaged in a strife, though a friendly one; then, that the contest was not on land, but on the water; and, finally, that in it were involved important questions of supremacy in naval design, construction, and seamanship. To the inland reader, familiar at best with no other craft than a river steamer, if indeed he had ever seen water enough to float a catboat, the technical details at first meant nothing; but, as the months went on, and every detail of the construction of the Priscilla in New York and the Puritan in Boston was faithfully chronicled by the whole press of the country, the nation at large began to awaken to the fact that there was water outside of the United States, as well as mountains and prairies inside; that it was fighting on the water, though only in sport, against a foreign foe; and that some day it might be called upon to fight in earnest. The object lesson—and it was sorely needed—was thoroughly laid to heart; and when, in the fall of 1885, the news of the last great race and of the hardly won victory of the Puritan over the Genesta, and of the great triumph of Burgess, the modest American designer, was flashed over the land, among those who rejoiced most were many who had no definite idea of a yacht, but whose ignorance on this point in no way dimmed their joy over the national triumph.

The races of the next year, with the Mayflower, an improved Puritan, opposed to the Galatea, the newer and larger sister of the Genesta, awakened a still wider interest; and when, in 1887, this second victory was succeeded by a third,—of the Volunteer over the Thistle,—the whole nation shared in the triple triumph of Boston.

The far-reaching effect of this great series of international races has never been properly appreciated. The immediate effect was plain; a wider and deeper interest in yachting was awakened throughout the country, yacht clubs were formed in remote places, and in the old yachting centers a new enthusiasm was noticeable. Yacht building took on an unwonted prosperity, orders coming in for craft of all sorts, wood and steel, sail and steam. In design and construction very great advances were made as the result of the study of the foreign challengers, the new compromise yacht being safer, faster, abler, and far stronger than the old-time sloop. The subject of design received for the first time that attention which it deserves, and the importance of the professional yacht designer was generally recognized. A review

of the yachts of 1888 beside those of 1880 would bear testimony to the vast improvement in every respect.

While the gain in such material points can hardly be over-estimated, it was but small compared with that in another direction. It was much to have produced a faster yacht than the old cutter, and a far safer yacht than the old sloop; but it was much more to have brought home to the people of the United States, without regard to locality or occupation, the great fact that the nation must, at any cost, maintain her supremacy upon the sea. This was the lesson of the Cup races of 1885, 1886, and 1887,—a lesson that is told anew with every fresh contest.

The work of equipping the navy of the United States with vessels of modern type began several years prior to the Puritan-Genesta races, a comparatively small sum of money being appropriated to the first vessels. Even this was given grudgingly; the farmer, the miner, and the merchant of the interior had no conception of the proposal to spend a million dollars or more in a single vessel, save as a job, nor were their representatives in congress inclined to be more liberal in providing an adequate coast-defence fleet. At a most opportune moment there came the challenge from the Genesta for the America's Cup, the work of preparation, the battle, and the victory appealing to the whole nation in the strongest way. The first interest of the inland American was awakened solely through his love of sport and a feeling of rivalry toward England; but, as one successful contest followed another, these gave place to a deeper feeling; the dormant love of the sea and pride in sea power inherited from sailor ancestors, but almost extinguished by purely inland pursuits, were at last aroused.

The result of this revival is seen to-day in the new navy of the United States, strong already in the possession of some of the finest vessels afloat, and growing year by year. The vast amount of money expended in the past 10 years in war vessels has come, not alone from the great cities of the coast within reach of the guns of a hostile fleet, but from the length and breadth of the nation. As a means to such an end, the construction of racing yachts of the highest possible speed can hardly be over-estimated, whatever their cost.

The immediate influences of the international races of recent years are many and far-reaching; the competition of the designers has resulted in a greatly improved construction, and in the production of greatly superior materials in the way of steel and other metals for hulls, of canvas for sails, and of wire rope as soft and pliable as cotton, yet with the strength of steel, for rigging, both running and standing. The tendencies of yacht designing under the stimulus of strong competition are varied, and not always of the best; the winner of one year

may be such an ideal vessel as the Volunteer or the Minerva, while the next season may witness the triumph of such a racing machine as the successful Niagara; but with all this the advance in designing within the past 10 years is most marked. The old ideas and theories of yacht designing have given place to others far more in consonance with the laws of nature and the most advanced theories of scientists. The designing of yachts has passed from the hands of the builder to those of the trained yacht designer; the laws of stability and the value of proper ballasting—the two elements on which depend the safety of a yacht—are now generally understood and observed. The whole maritime world has been placed under obligations to the yacht designer and the racing yacht for the development of the peculiar form first embodied in the successful Gloriana, and for the accompanying theory of the use and value of a round and full waterline and diagonal in place of a hollow bow. First tested in yachts, this theory has been applied most successfully in the fast Sound steamers Richard Peck and Lowell, by Mr. A. Cary Smith, the yacht designer; and it is destined sooner or later to work a material change in the models of ocean vessels.

The advance in technical education in naval matters has kept step so closely with the recent progress in yachting that it is impossible not to associate them as effect and cause. Up to a very recent period the disregard of all that pertained to naval science was little less than a national disgrace; there was not an institution in the United States which taught the elements of ship designing and construction, and the few graduates of Annapolis who devoted themselves to these important branches were indebted to the courtesy of the British government for instruction in its naval colleges. The skill and craft of its shipbuilders, once a source of national pride in the days of Webb, Steers, Bell, and Eckford, were no longer recognized throughout the maritime world.

The condition of naval designing to-day is still far from satisfactory, but much has been done. Excellent technical instruction is given at Cornell University and other institutions, and the value of a thorough scientific training for the designer and marine engineer is now generally appreciated. It is in yachting that the greatest progress has been made; not only have the American designers, Burgess, Smith, and Herreshoff, shown themselves fully able to compete with those of other nations, but among yachtsmen at large there are hundreds of amateurs who have devoted themselves to the science of designing, who are qualified to discuss intelligently the design and construction of vessels, and who are fully alive to the great importance of such technical knowledge.

Much remains to be done; there should be within the reach of

every ambitious boy the same opportunities for thorough instruction in naval design and marine engineering as have long been afforded in civil, mechanical, and electrical engineering and kindred professions. For more advanced students there should be one or more institutions fully equipped with the best instructors and the finest mechanical appliances, with suitable inducements and opportunities for those whose tastes run in the direction of experiment and investigation. As yet this country does not boast of one experimental tank for the trial of models by towing, though such are found in the private shipyards of England, apart from the magnificent government plant under the care of Mr. R. H. Froude. The necessity for advance in this line of work becomes more pressing each year, as the modern warship increases in cost and complication and the margin of profit in merchant vessels becomes smaller through competition.

Looking now from the ship to the sailor, the influence of the yacht races has served to bring many recruits to the ranks of yachtsmen, boat sailors, and canoeists; and pleasure craft of some kind may be found wherever there is water, even in the most remote localities. The mere ownership and use of a boat, however small, is an earnest of a man's interest in the sea, and, multiplied by thousands, it becomes a material element of strength to a nation with such a sea-coast as ours The old type of yacht owner, trusting everything to his captain and indifferent to the technical side of the sport, has given place to the modern Corinthian, who rests not until he is fully posted on every detail of practical yachting, from the design and construction of his vessel to her handling in all emergencies. In the service of such owners are thousands of hardy tars, not all of American birth, most of them Scandinavians, but honest, capable, and fearless sailor men, born beside the sea, brought up in coasters and fishing smacks, and finding their way into American yachting after long sea voyages in all climes. Apart from their nationality,—and this is no serious practical drawback,—they form an immense reserve of experienced seamen, instantly available for use in time of war.

It is with the modern type of American yachtsman, keen, alert, and intelligent, that the new Naval Reserve originated, and from this type it derives its strength. Though yet a child in years, it is strong, vigorous, and rapidly growing, thanks to the firm foundation on which, after the failure of the first attempt in other hands, it was established by some New York yachtsmen. The value of practical yachting as a naval training school has already been demonstrated by the work of the Naval Reserve in its annual cruises, the members showing a remarkable aptitude and intelligence in work with the great guns, and other manœuvers in which they have had no previous practical experience.

That yachting has done much for the nation, and is now doing more, can not be denied; what, then, has the nation done, and what should it do in return, if merely for its own benefit? Like most independent Americans, the yachtsman is opposed to a paternal government; he asks no coddling or special protection; but he does ask to be let alone, so far as possible without conflicting with the general policy of the government This privilege, be it said, has not always been accorded to him in the past, and even now he is the victim of red tape and official meddling at times. It is to the credit of the nation that the attempt made a few years ago by some political partisans to hamper and annoy American yachtsmen by the imposition of absurd and unnecessary restrictions, such as denying to American owners the right to fly the national ensign on yachts of American build if under 5 tons, and similar unjust provisions, was an utter failure, resulting in even more liberty than before. There is still much that might be done, however, to relieve the yacht owner of useless restrictions which, though partly dead letters, are at times a source of serious annoyance at the hands of ignorant or dishonest officials. The laws relating to pleasure vessels might be very thoroughly amended, giving greater liberty to the yacht owner, with due regard to the necessary customs and health regulations; and any such amendments should be framed, not in the hostile spirit of the so-called Frye bill, but with a view to promoting the building, ownership, and use of pleasure vessels of all types and sizes. In the way of direct government aid the yachtsman asks nothing; from the very nature of the sport there can be no question of gain or profit connected with ownership of a yacht, and the owner is prepared to pay liberally for all that he receives.

The question of government aid to yacht owners, and of a return from them, has lately been brought forward through an article by Hon. Wm. McAdoo, assistant secretary of the navy, in the *North American Review*, in which is suggested a system of government supervision, with the consent of the owners, over steam yachts of the various classes, full-powered, auxiliary, and high-speed, with a view to their conversion into despatch boats and torpedo boats in time of war. Ingenious as it is, the plan is not likely to work in practice; yachts of the largest class, such as the Electra, Sapphire, Sagamore, Columbia, and Nourmahal, with the smaller Wild Duck, Now Then, and Norwood, though very costly, lack the essential qualities of speed and endurance. One great element of their first cost—the magnificent furnishing and upholstery—would be practically thrown away at the start in the attempt to convert them into despatch or torpedo boats, leaving in most cases a hull of limited speed and bunker space, which could be strengthened and altered to carry the necessary armament only by a very large

outlay. Such a change might be made satisfactory to the owner by the payment of a very large price for his yacht, but it could hardly be satisfactory to the government when the cost and character of the yacht-torpedo boat is considered. In the case of the fast launches, similar difficulties exist ; the boats are very costly and entirely too delicate for the proposed service.

While some of the difficulties disappear in the case of new vessels specially designed and constructed for this double use, there would still be the enormous expense, to be borne by one of the two parties, of the practical destruction of the entire interior fittings,—a very large item in the total cost of a steam yacht. This same question of costly furnishing would also bar the use of the yacht by the government for a short period each year,—an integral feature of the scheme.

A better solution of the problem may be found in the offering to yachtsmen of every possible encouragement to build and to experiment, to test new metals and other materials, and to indulge at their own expense in those costly experiments to which they are as a class inclined. At the same time all possible encouragement should be given to the advance of naval designing and to the improvement of building plants. The construction of a steel vessel 200 ft. in length is a comparatively simple and speedy matter to-day with good designs and an adequate plant ; a certain number of vessels are, or should be, immediately available in the event of a sudden emergency ; and, should the trouble be of long duration, others of the required types can be quickly built, at far less cost and of greater efficiency than any converted yacht.

THE CUBAN REVOLT: ITS CAUSES AND EFFECTS.

By A Native Cuban.

IT has been justly observed by Mirabeau that, when the people complain, they are always right. Now, the Cubans have been complaining bitterly, for a long series of years, of Spanish misrule and oppression, until to-day, as often heretofore, their patriotic protestations against the tyranny of a medieval monarchy find expression in the click of the rifle and the sharp clash of the sabre and *machete*. The evils at the root of this disaffection lie deep in Cuban soil, and have already yielded, and are now producing, their natural crop of rebellion, so-called treason, sanguinary battles, and—promises of reform! From the earliest dawn of the history of that beautiful, but unhappy, island, from the ill-starred hour when Velasquez invaded the land of Hatuey, from the days when liberty, naked and unfettered, roamed the hills and valleys of the new world, to this our own day, Cuba has lain under the iron rod of one of the cruellest of European oppressors. The Indian Cacique, whom Velasquez burned at the stake four hundred years ago, thought that paradise with Spaniards were worse than hell without them, and in this very hour the descendants of those same Spaniards, the very flesh and blood of the old race, have risen in their anger against the exasperating tyranny of their rulers; and, in the face of dreadful odds and utter, irretrievable ruin if unsuccessful, the patriotic band of Cubans in the field to-day will do or die in the cause of independence.

For some three hundred years the governor-general of Cuba has been the power that ruled the destiny of the people; his sway has been absolute; his command the law; and the same condition of autocratic authority practically exists at present. The governor is the commander of the army, and his commission is unrestricted. True it is that Cuba sends some representatives to the Spanish cortes, but, as they are there in a hopeless minority, it were better that they stayed away.

In 1836, a constitutional government was adopted for Spain, but Cuba did not share in the feast of liberty, meagre though it was.

Fearful of the effects of the growth of education, power, and wealth that Cuba would enjoy under the full measure of political justice to which, as a part of the kingdom, she was entitled, the Spanish government excluded Cuba from the operation of the constitution, declaring that she should be the subject of special laws. Those

special laws meant martial law and a continuance of the old iniquities. It was then that Cuba, "the fairest jewel in the crown of Spain," began to lose its lustre and become dimmed with the shades of blood. Strenuous efforts, but unavailing, were made to bring about a satisfactory political status without severing the fanciful bond that united the island to the antiquated monarchy 5000 miles away; and at last, following the example of the American colonists, the banner of revolt was raised upon her plains, and for 10 long years an unrelenting warfare was maintained against the Spanish hordes. This struggle of an impoverished, oppressed, and poorly-armed people against a foe possessing every advantage which the Cuban lacked did not end, as would naturally be expected, in the defeat of the rebel, or, rather, the patriot army. No; peace was secured by Spain through General Martinez Campos, who made satisfactory *promises* of reform in accordance with the demands of the Cuban leaders. These promises were fulfilled in the Spanish manner, and Cuba will not, hereafter, entrust her destiny to the frail keeping of Spanish faith.

Since 1878—that is, for 17 years—the Autonomist party, composed of the most able andenlightened natives of the island, has been urging, in a respectful and peaceful manner, upon the step-mother-country the substantial fulfillment of the promises made by Campos in the name of Spain in 1878, relying upon which the revolutionists laid down their arms and returned to the paths of peace and slavery. But Spain, old, blind, and decrepit Spain, deaf to the pleadings of her own grand children, broke the pledges so solemnly made, although at the same time pretending to comply with the requirements of the Cuban people. The Autonomist party, so long as the people of Cuba were patient beneath its control, may fairly be said to have represented the majority of the inhabitants, but it ceased to so represent them the moment the people broke away from its guidance, and, as a representative party, it does not exist to-day. During its political life the Autonomist party, upon many occasions in the Spanish cortes, warned the government that it would not be responsible for any future attempt at rebellion by the disappointed Cubans; and, indeed, the Autonomists are in no wise responsible for the present uprising of their quondam political constituents.

The government system in Cuba is, and has always been, to the advantage of the Spaniard, and to the loss and detriment of the native, and consequently a hindrance to the material development of the industrial resources of the land. The tariff duties, the internal revenue taxation, the personal taxes, and the fees to custom house officials, together with the exasperating delays,—which can sometimes be avoided, also for a fee,—are all contrived to benefit the Spanish office-

holder at the expense of the local native merchant. There is no civilized people on earth, with whose history we are acquainted, so heavily taxed as the unfortunate Cuban, nor is there a country on the face of the globe where the taxpayers have so little—in fact, absolutely nothing—to say regarding the governmental disposition of the money which they have paid. With Cuban funds, extorted from the pockets of the working people, Spain maintains an army and a navy like those of the United States, while a very small percentage of the revenues are disbursed for the education of youth. In fact, the expenditure of the island's revenues is the business of Spain; all Cuba has to do is to furnish the money,—Spain does the rest. And it ought to be generally known, although it seems not to be, that every position upon the island in the gift of the government is bestowed upon Spaniards imported for the purpose of enjoying the emoluments of office. There it is not a question of political party among the natives, but one of conqueror and conquered; the plums—rind, kernel, and all—are for the Spaniard, and nothing is left for the Cuban but submission or revolt. To every American, aye, to every man with a heart in its right place, revolt is better than submission to tyranny, and revolt has been the alternative chosen by the Cuban patriots. Under Spanish domination the industry and commerce of the island have been at their lowest ebb, and that Cuba has been at all able to bear the steady drain of the Spanish plunderer is solely owing to the lavish hand with which she has been endowed by nature with resources really inexhaustible and, as yet, practically untouched. It is to rectify these glaring imperfections in the political economy of his native land that the Cuban has taken down the old musket and refurbished the rusty sword, and it is for this that the mountain slopes and lovely vales of the paradise of the west are to-day echoing the din of battle and, let us hope, the shouts of Cuban victory.

It has been asserted, and maintained with some degree of pertinacity, by Spanish organs that the spirit of the present revolution in Cuba is a dark one; in other words, that it is a race war, based upon racial enmity between the colored population and their Spanish governors, and that the success of the Cuban arms will mean the accession to power of the colored element upon the island. It is also pretended that the white population of Cuba are eminently contented with the Spanish *règime*, and are willing to again trust to a repetition by Martinez Campos of the promises which he made in 1878. Nothing of the kind. The white population of Cuba are sufficiently intelligent to appreciate the value of such promises, and will rely upon them no more. Aided by their patriotic colored brethren, the inhabitants as a whole, white and black together, are making the present fight, and the

statement that this is a struggle between the white and colored races is as false as it is base. The colored population, upon the one hand, number only about four hundred thousand, and of this number hardly more than one third can read and write. Upon the other hand, there are, at least, twelve hundred thousand white inhabitants, all of whom are as intelligent and as well educated as the average citizen of the United States. To talk, in view of these figures, of an eventual colored government for Cuba is simply absurd; so that we shall say but little more about it. It is sufficient for us to know that in the heart of our colored brother there is the same spirit of patriotism which animates our own, and both of us can contemplate with affectionate pride such a noble example of heroic devotion to liberty as was presented by Plácido, whose country was the idol at whose altar he sacrificed his life. In proof of the falsity of the allegation that race prejudice is the chief element in the present struggle, it is only necessary to advert to the fact that there are under arms in Cuba at least twelve thousand white rebels. If there are as many colored patriots fighting for independence, it is probably owing to the fact that the revolution began in a province where the colored population was much greater than the white, and it is this very circumstance which has been seized upon by the enemies of Cuba to lend color to the lie that the fight is one of race, and not the expression of the healthy sentiment of the majority of native Cubans. Indeed, some of the most distinguished—I was about to write aristocratic—white families of the island have sent members to represent them in the rebel camp. The Marquis of Santa Lucia, a venerable patriot belonging to one of the very first families of Cuba, is actually in the field; Bartolome Masso, an eminent white Cuban of large wealth, is a general in the insurgent army; Rafael Portuondo, a well known and able lawyer, and a member of a first-class family of Santiago de Cuba and Gen. Juan B. Zayas, son of a great Cuban scholar, are fighting in the ranks of the patriots; Francisco Sanchez Echevarria, who belongs to the cream of Cuban society, a man of wealth and great social attainments, has just successfully landed on Cuban soil an expedition with a large quantity of ammunition for the insurgents; and he has with him Señor Miguel Varona, a son of the greatest living Cuban philosopher. All these gentlemen, and many others high in the social scale of Cuba (which, by the way, is very delicately adjusted), most of whom have been educated in the United States, are heart and soul in active sympathy with the revolutionists, and are actually jeopardizing their own lives and fortunes in defence of their country's honor.

If this were a race war, those gentlemen would never be found within its ranks, nor would it receive the sanction and support of such

men as Estrada Palma, Ponce de Leon, Francisco Sellén, Juan Bellido de Luna, and a great many other eminent Cubans, who are truly representative of the best elements of the island in education, conservatism, and personal worth.

That the fight will be a bitter one there can be no doubt. As late as last January the Spanish prime minister, Sagasta, in a speech delivered in the cortes at Madrid, declared that Spain would lose her last man upon the battle field and would spend her last dollar before she would consent to grant autonomy to Cuba. In this respect the attitude of Spain is characteristic, not to say quixotically so. It is alleged that Cuba is a continual source of outlay to the Spanish government. Perhaps so. It certainly is in anxiety and in blood, and the sooner the Spanish purse is exhausted, the better it will be for Spain, the better for Cuba, and the better for the entire western hemisphere.

But why is it that Cuba, so rich in her own resources, should prove a burden rather than a valuable possession of the Castilian crown? The answer is simple. Spain, instead of permitting able natives of Cuba to participate in the administration of the affairs of the island, sends over a horde of office-seeking, indolent, and insolent Spaniards, who are ignorant of the island, of its advantages, and of its requirements,—a band of men who have no affection for the country, or family-ties to unite them to the land, and whose sole object is personal aggrandizement within the shortest possible space of time. These people, in fact, take the revenues, and regard their offices merely as so many instruments by the use of which they can "bleed" the Cuban to their own advantage. In a word, the reason that Spain derives so comparatively small a revenue from Cuba is that Spanish employees steal. Cuba is certainly not to blame for Spanish theft.

Upon what ground of logic Spain can defend her possession of other people's property we know not; but certain it is that the exercise by Spain of dominion over Cuba has paralyzed the wonderful opportunities which that country would otherwise present to the enterprise of a free people, and, by exclusion, it has deprived the United States and the other countries of this continent of business amounting perhaps to millions. The Spanish government has never favored enterprise between the native Cuban and the outside world. Foreign capitalists neglect Cuba, since there is no security there or guarantees upon which to rely for the safety of investments. Well-informed merchants know how high Spanish duties are upon all kinds of foreign merchandise, and especially upon the necessities of life, such as flour, and, if they have ever done business with Cuba, they will undoubtedly retain some unpleasant recollection of custom-house restrictions and espionage almost sufficient to cause them to look elsewhere for a market.

And now, of course, pending hostilities which may, like the late war, last a decade, if not longer, the business of the island with the outside world is dead, and the commerce of Cuba with the United States is necessarily stagnant and must remain so until tranquility is restored and the great pulse of commercial life begins to beat again with rhythmic regularity. In Cuba it is well known that the situation is a very serious one for Spain, and it is impossible to tell what changes a very short time may cause in the financial system of the government. Hence, until peace be reëstablished, the business world will not exchange with Cuba, and her markets must remain closed until a happier day.

Should Cuba succeed in shaking off the Spanish yoke and establishing a republic within her borders, the effect upon the commerce of this country with Cuba would be incalculable. The American people can hardly realize the marvellous wealth of Cuba. She has been favored by nature with gold and silver mines enough to enrich the earth. Mountains of manganese are awaiting the enterprising capitalist who will convert them into wealth. Her forests are stocked with rare and precious woods, and her soil is as bountiful as any other on the globe. And yet is Cuba poor. All these natural stores are unproductive and undeveloped, because of the timidity and distrust of the American capitalist. He dislikes—and who can blame him?—to exploit a country which is liable at any time to be shaken to its center by the guns of revolution. With reasonable security upon which to base his enterprise the American capitalist would safely enter Cuba and reap untold wealth from the great field which lies there undeveloped, ready to respond a thousand-fold to the magical touch of the genius of American industry. Such a condition can prevail only when the Spanish government does not exist in Cuba. When it is no longer a figure in the theatre of Cuban affairs, then will that country naturally turn to the United States as its next-door neighbor, and deal with her rather than with others.

Geographically, Cuba is a portion of the North American continent, and no more belongs to Spain, except by the power of the bayonet, than does Florida. To whom, then, if not to the United States, would the marts of Cuba be opened upon a profitable basis to both parties? With the mind's eye we may stand upon the Cuban shore and gaze upon the commerce of all the Gulf of Mexico, we may trace the barks laden with merchandise upon the Mississippi river, and we may even, in fancy, cast our glance across the Isthmus of Panama and view the busy world that animates the Pacific slope upon the other side. Thus situated, Cuba would necessarily become a favorite market for United States goods; and, reciprocally, the markets of the United

States would receive the attention of the Cuban merchants and manufacturers. Indeed, for the limited trade which, under existing political circumstances, Cuba has been able to effect, it may be said that she is already commercially annexed to the United States, which have ever been her model in her struggle for commercial prosperity as well as for political freedom and self-government.

Whether Cuban independence would lead to the annexation of the island to the United States is a rather difficult problem; but it is certain that, once severed from Spanish thraldom, the island would never again be controlled by any European power. It is likely that the Cubans would, at first, endeavor to establish a republic, as they feel themselves entirely capable of self-government.

The prosperous condition of such towns as Key West, Tampa, and Ybor City, in Florida, which are exclusively Cuban colonies, shows what, under favorable political conditions, Cubans can do in the way of self-government and material prosperity and advancement.

Besides they possess a sentimental and national fondness for their beautiful language, which would cause a large portion of the population to desire that the country should remain as a distinct nation, fearful lest, by becoming an integral part of the United States, they and their language might become absorbed and finally disappear altogether in the great country to which they would be wedded.

But this is, at best, only a minor consideration. With or without annexation, a close intimacy must exist between the two countries, and, while the loss of the Cuban language would be less rapid in one case than in the other, still, if the fear of absorption be well grounded, such will be its fate in either event.

If the arrogant assertion of Spain that the Cubans are unqualified to administer their own affairs be true, they would naturally look to the United States and ask this country to open its arms and receive them into the Union. This, however, seems to be a remote probability, as the Cuban people are generally as well educated as the average American, and are, at the same time, much better adapted to govern themselves than the Spanish government is to govern them. Indeed, the spectacle of the Spanish government itself to-day is far from satisfactory.

It is obvious that annexation would be of great commercial benefit to both countries. The international barriers to commercial intercourse would be removed, and the same facilities would exist between the United States and Cuba as now prevail between New York and New Jersey. The demands of commerce would be met by the construction of railroads and bridges, giving employment to thousands of artisans in all departments of industry. It should be remembered,

too, that Cuba is the greatest sugar-producing country in the world, and the development of this branch of trade alone would offer a large field for the introduction of American machinery, which has already, in the few plantations where it is employed, given results of a most satisfactory character. With Cuba free, an astounding impetus would be given to its commercial activities; engineering, in all its branches, would be called into active employment upon the island; agriculture, with its improved and labor-saving implements, would stimulate the rich and luxurious soil to the production of its choicest treasures; roads would be laid and aqueducts built; and the people, joyous in the sunshine of that freedom for which they are so bravely struggling, would turn their attention to the construction of homes, thus giving employment to architects.

The climate of Cuba would attract to the island thousands of Americans, especially in the winter season, and this increased traffic would necessitate the construction of first-class modern steamers to ply between the ports of the United States and those of Cuba.

These results would necessarily flow from the liberation of Cuba from Spanish dominion, even if it were not followed by annexation. The proximity of Cuba to this country would naturally produce that communion of interest which would lead inevitably to closer commercial relations between the two countries, and such fellowship would bring in its train a large measure of mutual prosperity.

It is for all these reasons, sentimental as well as practical, that the torch of revolution has been lighted in Cuba, and it is safe to say that, whether successful or not on this occasion, the people of Cuba will continue the struggle until victory perches upon their banner, and not a trace of Spanish rule, save the graves of Spanish soldiers, remains to remind her of her 400 years of intolerable bondage, wretchedness, and ruin.

To this end our people shall ever cry:

"A las armas, compañeros!
Viva el sable y el fusil!"

THE CANADIAN LUMBER INDUSTRY.

By J. S. Robertson.

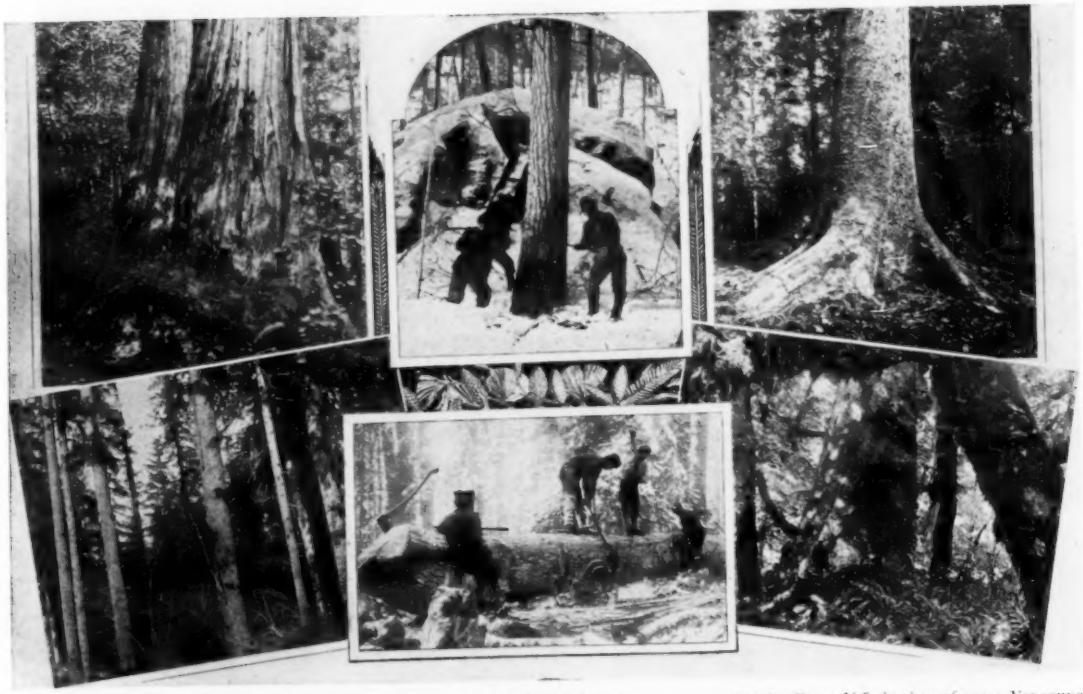
THERE was a time when, to quote the language of a certain class of Englishmen, Canada was known as a "blawsted wooden country." The imputation, though made in cynicism, had much evidence behind it, for in the early history of the country the forests of Canada extended in an almost unbroken stretch from the Atlantic ocean to the head of Lake Superior,—a distance of 2000 miles.

The Dominion of Canada has an area of not less than 3,456,383 sq. miles; that is, it is 430,783 sq. miles larger than the United States, if Alaska be excepted, and almost as large as the whole continent of Europe, which has 3,756,002 sq. miles. This territory is divided into provinces as follows: Ontario, Quebec, Nova Scotia, New Brunswick, Prince Edward Island, Manitoba and the Northwest Territories, and British Columbia, all of which are rich (in some measure at least) in forest wealth. The total population of Canada, according to the census of 1891, is 4,833,239.

Next to agricultural pursuits, in which 56 per cent. of the population are engaged, lumber is the most important industry of the Dominion. There is an invested capital in the business of nearly $100,000,000, and an annual wage-list of over $30,000,000, with an output valued at almost $110,000,000. Of saw mills and wood-working establishments there are about 6000, giving employment during the season to not less than 15,000 men.

The value of forest products, calculated from the census returns of 1891, is given by Mr. Geo. Johnson, government statistician, as $80,071,415. For the fiscal year 1890–91 the imports of wood articles amounted to $3,132,516, while for the same period the exports were $27,207,547, leaving for consumption in Canada $55,996,384, or a value of $15.59 per head. The census returns show an aggregate of 2,045,073,072 cu. ft. as the total cut of the year. About 30 per cent. of this is exported, leaving 1,431,551,150 cu. ft. for the annual home consumption. This is equal to 296.2 cu. ft. per head of the population, the estimate of Mr. B. E. Fernow for the United States being 350 cu. ft. per head.

As each of the provinces of Canada has an individuality of its own, geographically and physically, so has each its own individuality as a lumber centre. Canada's reputation as a "wooden country" rests primarily on the fame of its white pine (*pinus strobus*) in the prov-



Cedar Tree 53 ft in circumference, Vancouver.
Forest Trees, English Bay, Vancouver.

Cutting in the Forest.
Squaring Timber.

Douglas Fir, 37½ ft. in circumference, Vancouver.
Spruce Tree, 44 ft. in circumference, Vancouver.

ince of Ontario. It is improbable that any one has learned anything of the lumber history of this country without having obtained a knowledge of the immense pine resources of the Ottawa valley and the Georgian bay districts. Ontario is spoken of as the great white-pine field of the Dominion, just as Michigan, Wisconsin, and Minnesota go into history as the great white-pine States of the American Union.

The ownership of Canadian forests is, for the most part, invested in the provincial governments, and in Ontario, in particular, the management thereof constitutes the most important department of government. The department of crown lands, which has the admin-

IN THE FOREST ON THE OTTAWA RIVER.

istration of the timber resources of the province, is the great money-making department of Ontario, and political opponents ofttimes inquire where the revenue of Ontario will come from when its forest products are exhausted? This department has been for many years under the control of Hon. A. S. Hardy, commissioner of crown lands, a gentleman whose name is frequently mentioned as the probable successor to the present premier, Sir Oliver Mowat.

The regulations respecting timber limits in Ontario are of importance to every one interested in this industry. Among other things they provide as follows:

That the commissioner of crown lands, before granting any license for new timber

HAULING LOGS IN THE FOREST.

berths (not including the lands) in the unsurveyed territory, shall, as far as practicable, cause the section of country where it is intended to allot such berths to be run into townships, and each township, when so surveyed, shall constitute a timber berth, but the commissioner may cause such townships to be subdivided into as many timber berths as he may think proper.

The berths or limits, when so surveyed and set off, and all new berths or limits in surveyed territory, shall be explored and valued, and then offered for sale by public auction at the upset price fixed by such valuation at such time and place, and on such conditions and by such officer, as the commissioner shall direct by public notice for that purpose, and shall be sold to the highest bidder for cash at the time of sale.

All lumber licenses are to expire on the 30th of April next after the date thereof, and all renewals are to be applied for and issued before the 1st of July following the expiration of the last preceding license, in default whereof the right to renewal shall cease and the berth or berths shall be treated as forfeited.

No renewal of any license shall be granted, unless or until the ground-rent and all costs of survey and all dues to the crown on timber, saw logs, or other lumber cut under and by virtue of any license other than the last preceding shall have been first paid.

All timber berths or limits shall be subject to an annual ground rent of $3 a square mile, payable only in advance before the issuing of any original license or renewal.

All timber, saw logs, wood, or other lumber cut under any license that may be hereafter granted shall be subject to the payment of the following crown dues: red- and white-pine timber, per cu. ft., $0.02; red- and white-pine saw logs and boom timber, per standard of 200 ft. board measure, $0.20.

Operating under these regulations, which are closely enforced by

the government, the cut of white-pine and Norway-pine lumber in Ontario amounts to about 700,000,000 ft. a year; taking the figures for the year ending June, 1893, the cut was 677,525,000 ft.

It is somewhat difficult to estimate the pine-timber area of Ontario. A return of the government of Ontario, brought down in 1893, says:

No estimate has been made of the quantity of pine timber standing upon the whole crown domain. There is a great stretch of territory lying north of the 48th parallel of latitude and the northern limit of Ontario and between 85th west longitude and the easterly limit of the disputed territory, in respect of which no estimate has been made at all, containing 89,000 sq. miles or thereabouts, much of which, it is known, is pine bearing, but other portions are not, and as to some other parts there is no information. What has been done is to take certain areas known to be pine bearing and apply a reasonable estimate to them as follows:

	Sq. Miles.
West of the Ottawa River and north-west of the limits sold in 1872 between 80 and 85 west longitude, and extending north to the 48th parallel of latitude	24,000
Between Ottawa Agency and sale of 1881 in the Nipissing District	410
	24,410

	Ft.
To this area an average of 1,000,000 ft. B. M. to the mile was applied	24,410,000,000
Col. Dennis, late deputy minister of the interior, estimated the timber in the disputed territory at	26,000,000,000
	50,410,000,000
There is now subject to license in Ontario about 20,000 sq. miles, which has been estimated to contain 500,000 ft. to the mile, equalling	10,000,000,000

This gives a total on the territory estimated of 60,410,000,000 ft., exclusive of the territory of which no attempt at an estimate has been made as above stated.

Value.

The bonus value of 50,410,000,000 ft. at $1.50 a thousand equals	$ 75,615,000
The dues upon this at $1 a thousand	50,410,000
	$126,025,000
Add for duty on 10,000,000,000 ft., estimated on licensed lands at $1 a thousand	10,000,000
Making a total of	$136,025,000

White pine limits in Ontario, though scattered through many hands, are largely held by the big lumbermen of the province, and of late years a very considerable part has gone into the possession of United States lumbermen.

LOG JAM ON THE NASHWAAK RIVER, N. B.

Mr. J. R. Booth, of Ottawa, has obtained fame as the largest lumberman in the world. He is an extensive owner of timber limits, and until a little more than a year ago operated what was generally conceded to be the largest saw mill in the world. This was destroyed by fire some 12 months since. Messrs. Gilmour & Co., of Trenton, hold a very prominent position as owners of timber-limits, as well as saw millers. At the government sale of limits, 2 years ago, this firm was a heavy purchaser, paying the largest price for a timber limit ever

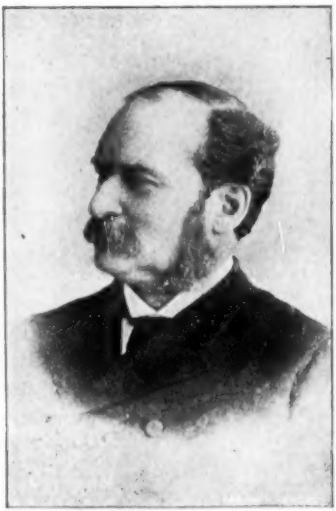
SLUICE GATES ON THE NASHWAAK RIVER, N. B.

DRAWING AND PILING LOGS ON THE ICE.

known in Ontario. Among other large owners may be named: The Bronson & Weston Co., of which Hon. E. H. Bronson, a member of the Ontario government, is principal; W. C. Edwards & Co., Buell, Hurdman & Co., Robert Thomson & Co., The Georgian Bay Lumber Co., and The Muskoka Mill and Lumber Co.

When, 3 years ago, the duty on lumber going into the United States was reduced from $2 a thousand to $1 a thousand, a great

LUMBER READY FOR SHIPMENT.



HON. A. S. HARDY.

stimulus was given to the lumber industry, and there followed one of the best years that Canadian lumbermen had enjoyed for a long time. But this reduction in the duty on sawn lumber carried with it the free export of lumber in the logs into the United States, and this immediately built up an immense business in the shipment of logs by raft from the Georgian bay shores to those of Michigan. These shipments have grown, until in the last year something like 400,000,000 ft. of logs were exported from the Georgian bay shores to Michigan mills.

When the Wilson tariff became a law, conditions again changed, and the Ontario holdings of United States lumbermen increased. To-day a large extent of the timber limits of Ontario is in the hands of J. W. Howry & Sons, J. T. Hurst, Albert Pack, A. T. Bliss, General Alger, Saginaw Salt and Lumber Co., and other well-known Michigan lumbermen.

To what extent the change in the lumber tariff will induce American holders of Canadian limits to build mills in Canada is a moot question. All lumber being free, it is as easy to ship the sawn lumber as that in the log, and, this being the case, it is contended that United States lumbermen will find it an advantage to own mills near the limits, cut their logs there, and ship the lumber to their own country. It is known that J.

HON. E. H. BRONSON.

W. Howry & Sons, who will this season rank among the largest operators in Ontario, have erected, or come into possession of, large saw mills in the province. At Midland a large mill is cutting entirely for an American concern, and along the Arnprior, Ottawa and Parry Sound Railway, 140 miles from Ottawa, the St. Anthony Lumber Co., owned by E. C. Whitney, of Minneapolis, and other American lumbermen, has built one of the largest mills on the continent.

GEN. R. A. ALGER OF MICHIGAN.

There are problems in connection with the Wilson tariff that may change the complexion of affairs. A change in government in the United States might lead to a reversion of free lumber, though the manner in which investments are being made in Canadian limits by United States lumbermen, who ought to understand the situation, does not give much force to this theory. Again, the question has been raised, only within the present season, whether dressed lumber, which is exempt from duty, includes flooring and other lumber that is matched and grooved. The board of general appraisers of the United States has ruled against this rendering, and, if the ruling is sustained, it will be a barrier to the establishment of planing mills in Canada. But, on the whole, there is reason to believe that free lumber has come to stay, and that it will, aside from an exception or two, operate in the interests both of Canadian lumbermen and of their congeners in the United States.

While white pine holds the lead among the woods grown in Ontario, there are other timbers possessing good commercial value. Some years ago Ontario was rich in many of the most useful hardwoods; there was hardly a county in the province that did not contain a good supply of maple, elm, ash, beech, and birch. But to day these woods, though fairly abundant, are to be found only in small quantities. The extent to which the forests have been depleted of some of the most valuable hardwoods gives to advocates of forest protection a most forcible text. The late clerk of forestry for the province of Ontario, Mr. R. W. Phipps, has pointed out, in way of illustration, that in Kent

E. B. Eddy's Mill.
Lumbermen's Camp.

Interior of W. E. Edwards' Mill, Rockland.

Driving Saw Logs, Gatineau River.
At Work in a Lumber Yard.

LOADING LUMBER AT J. B. BROOK'S DOCK.

county oak that sold 15 and 20 years ago at $4 50 per thousand feet could now be marketed at $25 per thousand, and walnut, which then brought only $14 per thousand feet, would to day command $100.

Crossing the border line to the older province of Quebec, we are brought face to face with lumber conditions of a different character. The chief lumber riches of Quebec, as also those of New Brunswick, consist of spruce. And whereas Ontario finds its principal and natural market for its forest products in the United States, Quebec's shipments are chiefly to Great Britain. There are several large concerns that look solely to the United Kingdom for their market. The area under license in Quebec, according to the statement of Hon. J. K. Ward, one of the oldest and most intelligent lumbermen of the province, is 48,000 miles, producing of spruce and pine logs 6,170,000 ft., equalling 683,000,000 ft. B. M.; of pine, spruce, and birch timber, 18,500,000 ft. B. M.; of railroad ties and other wood, 22,500 pieces, 12,000,000 ft. B. M.; pulp cedar, etc., 10,000 cords; revenue, $892,000. In New Brunswick the area under license is 6000 miles, producing, of pine and spruce logs, 87,000,000 ft. B. M.; of hemlock logs, 7,000,000 ft. B. M.; of cedar, 14,000,000 B. M.; of tamarac, 1,400,000 ft. B. M.; of pine and hardwood timber, 176,400 ft. B. M.; of boom sticks, 240,000 ft. B. M.; revenue and bonus, $102,000.

It is only within a few years that the spruce forests of Quebec, New Brunswick, and Nova Scotia have come to be appreciated at their real commercial worth, through the rapid development of the pulp-wood industry. It is conceded by some of the shrewdest manufacturers of pulp, not only in Canada, but in the United States, that these provinces have wonderfully rich resources in spruce, and this is in evidence in the fact that within a twelve-month large tracts of spruce land in Quebec, New Brunswick, and Nova Scotia have passed into the hands of syndicates composed largely of United States capitalists. Proof in the same direction is shown in the yearly increase of American importations. Exportation to the United States was inaugurated only 4 years ago. The figures are: $57,197 in 1890, $170,636 in 1891, $183,312 in 1892, and $454,253 in 1893, with a continued increase in 1894.

TRACTION ENGINE HAULING LOGS TO STREAM.

The reforestration of pine lands is a matter of many years, but experts testify that the young spruce will reach maturity in from 10 to 15 years. It will thus be seen that the owners of extensive spruce limits have within their possession an almost perpetual source of income. Pulp-making in Canada has within 10 years grown into an industry having nearly $3,000,000 of invested capital and over $1,000,000 of annual output. The lumber trade in New Brunswick has taken on new strength this year through the

J. B. BROOK'S MILL.

market found in the United States since lumber was placed on the free list.*

While the tall pines of Ontario have won the admiration of everyone who has made a study of the world's forests, yet to British Columbia belong the trees most admired both in the lumber trade and out of it. The giant cedars of California, whose story has been frequently told with pen and pencil, find their counterpart in British Columbia. There grow cedars of wonderful size and beauty. The red cedar of British Columbia is one of its most valuable timbers. With the forests of Ontario becoming all too rapidly denuded, it is proper to speak of

DINING ON A RAFT.

British Columbia to-day as the timber province of Canada. The forest area of British Columbia is 285,000 sq. miles, or 182,400,000 acres. Its density is as remarkable as its extent. It is on record that on one acre in the Comox district 508,000 ft. were found. This is, of course, exceptional, but the average is 75,000 ft.

Commercially the most valuable of British Columbia woods is Douglas fir, named after a noted botanist of that name. It is found generously distributed along the coast. Because of its immense length, strength, and straightness, for many commercial purposes it has no competitor. Some of these trees grow to a height of 300 ft., and

* Among the big lumbermen of New Brunswick are Hon. J. B. Snowball, Alex. Gibson, Malcolm Mackay, Geo. McKean, and E. Hutchinson.

SHIPPING LUMBER.

have a base circumference of 50 ft. The average height, however, is 150 ft., clear of limbs, and the average diameter 5 to 6 ft. Professor Macoun thinks that it will prove a valuable paper-making tree.

The red cedar (*Thuya Gigantæ*), of whose beauty I have already spoken, is very little behind Douglas fir in the race for commercial supremacy. For general purposes red cedar is doubtless the most valuable wood on the Pacific coast. Sometimes it reaches a height of 200 ft. and a diameter of 20 ft. The settler, when building his rude hut, finds a good friend in red cedar, while there are few woods that have been found more useful or beautiful for interior finishings in the finest residences.

But the woods of British Columbia are by no means confined to Douglas fir and red cedar. Species of spruce, hemlock, cotton wood, balsam, and even white pine, are to be found on the Pacific coast.

Saw-mill building owes its development in British Columbia largely to the past decade. There are about sixty saw mills in the province at the present time, with a daily capacity of over 3,000,000 ft. The cut of the province last year was 65,000,000 ft. The capital invested in these saw mills has been drawn largely from Ontario, some of the big mills being owned in the main by Ontario lumbermen. Ottawa lumbermen, too, have a considerable interest in the saw mills of the Pacific coat. The question is sometimes asked:

what is the possible longevity of the timber resources of British Columbia? One estimate, of a semi-official character, says that there are over 100,000,000,000 ft. of good timber in sight, and that, with the present saw mills making an average output, it would take between 150 and 200 years to exhaust the present supply. Another authority, however, estimates that it would last only 60 years.

British Columbia finds its main market for lumber in Great Britain, Australia, South Africa, South America, and other foreign points, with a new and growing market in California since the duty on lumber was lifted. The domestic market consists of its own province, with a good consumption in Manitoba and the Northwest Territories, while the red-cedar shingles of British Columbia have made their way in considerable quantities into eastern Canada, and have come into competition in certain sections of the United States with the Puget Sound cedar shingle, which is almost the same article. Mr. J. R. Anderson, provincial statistician, is authority for the statement that the yearly extent of lumber leases in British Columbia is 524,573 acres. The control of the timber resources of this province is mainly in the hands of the local government.

The province of Manitoba has little fame as a lumber district. Its great reputation is for grain, especially its hard wheats. There is a considerable saw mill and wood-working industry in this province, the supply of timber being drawn largely from the adjoining Lake of the Woods district, where timber is found in such abundance that United States lumbermen have their eye upon it. A considerable amount of lumber comes into Manitoba from Minnesota.

LUMBER YARDS, OTTAWA.

The growing uses of wood are so many and various that one can easily appreciate the remark of Mr. Atkinson in an article in the *Forum:* "The nations or States in which food, fuel, metal, and timber may be produced at the highest relative rates of wages and at the lowest money-cost per unit of product will thereby be enabled to apply labor-saving machines to other branches of productive industry in the most effective manner." Canada is rich in food products, for it is preëminently an agricultural country; in metal, it possesses an aggregation of riches that its people know little of; and fuel, whether wood or coal, is found in the Dominion in the greatest abundance. The figures which I have given leave no doubt of the extent of Canada's timber resources. In all particulars the requirements of Mr. Atkinson are fully met, and it is with a liberal measure of national pride that a citizen of Canada may refer to these matters, though recognizing at the same time that the cosmopolitan spirit of commerce lays open these vast riches to the entire world. Whosoever will may come.

RAFT OF TIMBER ON OTTAWA RIVER.

ARCHITECTURAL STUDENTS' WORK ABROAD.

By R. Phené Spiers.

IF, on the one hand, the multifarious duties which an architect is called upon to perform in the pursuit of his professional career involve an extensive range of study, there is, on the other hand, at least the element of variety in them; no one has ever conceived the idea that monotony enters into their sphere. It is precisely this variety which gives zest to an architect's life, and at no period of his career does it come in better stead than when travelling through Europe in the pursuit of general knowledge. The problem of opportunities for architectural students' work is probably best solved when face to face with the querist in search of advice, for then the special idiosyncracy of the student, his power of work, the particular course of study he is anxious to pursue, and the weak points in his elementary studies suggest the line of advice which should be given.

In the absence of any such direct intercourse, it is possible only to suggest the various opportunities which may arise, leaving it to the reader to select those which appeal most to his particular quest. Take, for instance, the cases of the late Mr. William Burges and the late Mr. George Edmund Street, who elected to pursue a particular phase of style. It would be difficult to find a wider divergence of methods than in those which they employed in order to make themselves acquainted with the forms and the spirit of the Gothic style. The former, being very short-sighted, confined his studies almost entirely to measured work, to the most careful analysis and dissection, so to speak, of portions of buildings, in some cases of considerable size, all of which he measured and plotted on the spot. He attached the very greatest importance to this last consideration, and it is necessary only to look through his valuable book on "Architectural Drawing" in order to recognize the immense value of such a course of study. The flèche of Amiens cathedral and the choir of Beauvais constitute the most valuable record it is possible to lay before any student; and, although it could scarcely be expected that many would have the courage to undertake so serious a task, these, though of little interest as show drawings, may be taken as models of the class of work which gave Mr. Burges the most intricate knowledge of the methods of framing timber in the one case and, in the other, of the execution of the most splendid masonry construction possessed by the carpenter and mason of the middle ages in France. Mr. Street, on the other hand, was the most prolific sketcher of the age; his custom was first

to pace and lay down the plan of the cathedral or church, by practice, in which he became able to grasp all the essential features at a glance; then to make a perspective sketch of the choir seen from the other side of the transept, of two bays of the nave, and of such external features as attracted his attention, in all cases with the profile of the mouldings; and these, with a few ornamental details, enabled him to store his memory with the ever varying phases of design. When at Mont St. Michel in Normandy in 1880, he told the writer of this article that he had paced and worked out the plan and drawn the choir of almost every important church in Europe, and that his reason for visiting Mont St. Michel a second time was that on his first visit, when it was utilized as a prison, he had been unable to get inside the church.

Mr. Street used a note-book of hot-pressed paper measuring 8″ × 6½″, and he frequently drew across the two pages, giving him a surface of 13″ × 8″. His sketches, though most carefully made, were not show drawings, and his lines were rarely drawn through; it was sufficient for him to show the leading features, such as the arches of the orders with the profiles at apex and springing the shaft capitals and the leading vertical lines, leaving all other lines to the imagination. His perspective sketches of some of the Normandy towers were so accurately drawn and with such detail of features that they virtually gave more information than a ¼″ scale elevation. Curiously enough, he never used india rubber; this, however, necessitated much greater care in the setting-out, and, as he scorned the use of the T or set squares when out for his holiday, it involved a greater precision in the drawing of horizontal, slope, or vertical lines.

The writer has lately had an opportunity of examining carefully the sketch-book of the late Mr. Wm. Eden Nesfield, who apparently never used india rubber. He occasionally ruled in a few vertical and horizontal lines, and turned in some of the curves of the arches even when in perspective,—very lightly, however, and only as guides for the remainder; these he does not seem to have thought it necessary to rub out, for they can be traced at intervals under the bold free hand curve quite as accurately as those turned in with the bow pencil. Nesfield used to be credited with having a *camera lucida* in his eye, for so completely did he grasp his subject, and so impressed had it become on his retina, that, though he were to leave the upper portion of his drawing and indicate some feature temporarily exposed in the lower part, the whole would come in right at the end. It may have been this gift which enabled him to devote his attention to that beauty of line which is so remarkable in his sketches.*

* Nesfield's sketches have just been published by some members of the Royal Institute of British Architects, and are now in their library.

To return, however, to Mr. Street. He occasionally made the most careful measured drawings, one of the most remarkable being that of Giotto's campanile at Florence. This was probably measured during its restoration about 35 years ago, when the whole tower was surrounded with scaffolding, and here it might be pointed out that unforeseen occasions present themselves which should be taken advantage of at once, even although it may upset the periods fixed for visiting other towns. Mr. de Dartin, professor of architecture at the École Polytechnique, Paris, obtained permission to measure the principal Lombard churches in north Italy at the time when the Italian nation, having entered again into possession, seized the opportunity to restore them. Mr. de Dartin could only count on his vacations for his work; so for 9 consecutive years he visited Italy and measured the buildings which are represented in his remarkable work, "L'Étude sur l'Architecture Lombarde et sur les Origines de l'Architecture Romano-Byzantine" (Paris, 1865–82). The steel plates of this splendid work were not only drawn, but engraved, by him.

Burges, it has been stated, never made perspective sketches; he made up, however, for the deficiency by the most diligent study, not only of architectural work, but of the various accessories. He made a special study of the stained glass of the French cathedrals, and is reported to have been the greatest authority on the iconography therein set forth. One other instance of his study is worth noting. When in Pompeii, instead of making water-color drawings of the wall decoration or of general views, which would have been difficult, owing to his short-sightedness, he made notes of the principles to be observed in the decoration of the various houses, with indications of the actual colors. Thirty years later he was destined to turn these memoranda to good account, for, when he was consulted about the restoration of the chapel of Worcester College, Oxford, built in 1714, the substitution for which of a Gothic structure had been suggested by Sir Gilbert Scott, he recommended that it should be retained, but refitted and decorated in color, and here, particularly in the ante-chapel, he recalled his recollections of his former studies in Pompeii.

The various descriptions of drawing in pencil or colors which may be adopted when travelling are detailed in the writer's work on "Architectural Drawing," published in 1887, so that it is not necessary to enter into that subject.

The opportunity for architectural students' work during tours may be divided broadly into two classes: those which have for their object the cultivation of the mind generally, with a view of developing the artistic powers of design; and those which are of a practical and utilita-

rian character, such as the study of the planning of public buildings, hospitals, etc., including their lighting, heating, and sanitation. As a rule, the English student confines himself to the first class, except in the case of the holder of the Godwin Bursary, a prize awarded by the Royal Institute of British Architects to encourage the study of practical architecture in countries outside the United Kingdom.

Although a systematic course of study is advisable more or less in both classes, it is specially necessary in the second; and perhaps the student may find his best incentive by assuming that he is required to draw up a report, or series of reports, on such subjects as hospitals and asylums, public libraries, polytechnic schools, railway stations, town halls, or the housing of the working classes, etc. In such cases plans are of the greatest importance, and those are not always easy to obtain, unless they happen to have been published in special works or in some of the professional journals, access to which can generally be obtained in the public libraries of the larger cities. It is, of course, important that, previous to starting on the journey, a special study should have been made of the class of building on which the student intends to report. In connection with such buildings heating, ventilation, and sanitation form very important factors, and should be included in the report.

It is, however, to the first class mentioned that by far the greater number of students devote themselves; and here so much depends upon the duration of the student's tour, the special course of study he may have in view, and, in some respects, his power of drawing, that it is difficult to lay down any exact rule. In England, within the last 30 years, it has come to be recognized, and it was always insisted by the late Mr. Burges, that "measuring and plotting on the spot" is one of the best means of acquiring a knowledge of ancient work. With all Gothic work it is imperatively necessary, and the same applies to the earlier phases of the Renaissance.

In Italian work there is so much repetition, and the proportions of the orders as adopted by the architects of the Italian revival have been published in so many works, that actual measurement perhaps may be dispensed with. As a rule, however, the publications referred to are not always reliable; they are frequently very inferior representations of the actual building, and in no case do they give any clue to the real construction; so that the student will derive benefit by adopting a similar course to that necessary for Gothic work,—*viz.*, measuring and plotting on the spot.

Except in buildings of small size, there is always some expense involved in measuring, and permission cannot always be obtained to fix ladders against a public building. In such cases photographs may be utilized; they represent the actual relative proportions, so that, by

measuring the plan and portions of the elevation, the remainder can be worked out from the photograph. It should be done, however, at the time, and an attempt made to work out the various projections and the mouldings of the cornices. When the late Mr. Burges was about to compete for the completion of the façade of the cathedral at Florence, he paid a visit to that town to study the building, and made use of a large mounted photograph, which cost him 15 francs. After paying for it, to the consternation of the shop-keeper he deliberately bent it in half, face outwards, to reduce its size, and eventually covered the margin of cardboard with sections of mouldings and other details. It was an exceptional act and done for a purpose, and there is no doubt that this photograph, with its margin covered with details, was of more value for reference than if he had filled his sketch-book.

Sometimes a small photograph will serve the purpose, and, if pasted in the corner of the note-book, with the drawings of mouldings and details filling up the page, it will have more real value than in the portfolio, with the drawings in a sketch-book. Perspective sketches of small portions of a building—detail of ornament and sections of mouldings—are sometimes better understood if a representation of the whole building, such as is given in a photograph, is appended. This, of course, assumes that the drawings are made for use, and not for show.

While the measured drawing gives the student a far greater knowledge of the actual construction than can otherwise be obtained, perspective drawings give the actual appearance; both should be used, one as a complement of the other.

To what extent the perspective drawing should be finished is a matter which depends on the subject. A mere sketch may sometimes be sufficient. Mr. Street's system of indicating the mouldings, the leading lines, and the lines of joining is perhaps the most valuable; but there are not many students who possess his knowledge, or the extraordinary grasp he was able to take at a glance of the constructional and decorative qualities in a building. This failing may be met by making a more careful drawing, in which the student should not fail to take advantage of the T and set squares, and, when possible, of the bow pencil. To attempt to draw even the leading lines of an early English or perpendicular building by hand alone may be good exercise, but it involves waste of time. Instruments were invented to facilitate one's work, and the artist will always know how to avoid the hardness of a drawing made by ruling in the leading lines. The late Mr. Joseph Nash, whose drawings of Elizabethan mansions are well known, utilized the T square, even when working with a brush and in body color.

This leads to the consideration of the use of color in drawings,

which may be looked upon as serving two purposes: first, the more actual representation of the effect of a building, where such effect is obtained by the juxtaposition of different materials, as red brick and stone, or, again, when colored marbles form an essential part of the design; second, the training of the eye. To travel through Italy and Spain and content oneself with perspective drawings in pencil only would be to lose a considerable portion of the special advantages to be derived from the study of the buildings there, in which color is one of the principal elements. To neglect entirely to record the effect of color in architectural work would be a mistake. But, beyond that, water-color drawing from nature gives the student one of the few opportunities which an architect has of training his eye to a sense of color, to harmonies and to contrasts.

The working drawings in an office are colored to define the materials only, and the tints are selected to show these clearly, and not in a decorative sense; in fact, in many cases the more violent the colors and their contrast, the better is the drawing understood by the workman. The pochades which a student may make in the evening after a day's hard work are also of great value in training the eye. Even those who are not gifted with a sense of color may take refuge in sepia or other monochrome drawings, in which the interpretation of values in nature and the massing of architectural forms constitute a useful and interesting course of study. On the other hand, there is some danger in the fascination of water-color, which is apt to lead the student from the more serious purpose of his tour. This, of course, does not apply to the studies of painted decoration, such as is found in Pompeii and in the various churches of Italy, or to mosaic work on walls, pavements, and vaults, all of which are proper and legitimate, besides being valuable as a training to the eye and affording a variation from measuring or drawing in perspective.

THE FUTURE OF THE ELECTRIC TELEGRAPH.

By Patrick B. Delany.

THE future of the telegraph will depend largely on the telegraph of the future. The telegraph of the present is, in its main features, the telegraph of the past, and, if it is to continue without material change, it is an easy matter to figure out its future, upon the basis of so many feet of wire for each inhabitant.

We have now about 1,250,000 miles of wire to sixty-five million people; but the probabilities are that, when we reach Mr. Gladstone's four hundred million mark, there will not be as many miles of telegraph wire as there are at present.

It does not require much foresight to realize that the final destiny of the telegraph is to carry all correspondence of any urgency, and that the present method of hand working, with its slow speed and multiplicity of wires, will give place to automatic or machine transmission, high speed, and fewer wires.

At present, owing to the expense, the telegraph is used only in cases of urgency, commercial or social. If a despatch could be sent as cheaply as a letter, the mails would dwindle to a mere miniature of their present bulk. In the commercial aspect it is simply a question of time against cost. Where "time is money," the telegraph claims its tolls. But there are degrees of urgency below the extreme which demand quicker communication than that afforded by the railway train; and the telegraph of the future will recognize these degrees of urgency and provide for them. With the exception of the half-rate night messages, telegraph companies have never attempted to differentiate their facilities. Messages, as a general rule, have been forwarded in the order of filing. In a case of life or death no one can acquire, by offering double, or a hundred fold, the usual rate for a telegram, the right to insist on precedence. It is optional with the company to push the message ahead of comparatively unimportant traffic, or transmit it in its turn.

There are fast trains, and fast steamers at premium rates; fast freights, and extra-delivery letters; but, except in the case of the night message, a telegram is a telegram, and haste goes only by favor. Common sense surely points to a change in this way of carrying on telegraphy. The Morse key, relay, and sounder, with hand transmission, are, and will probably for a long time remain, indispensable for a certain class of business,—*i. e.*, broker messages, train orders, and other despatches requiring instantaneous transmission. No automatic

system requiring preliminary composing or preparation of messages will ever meet the requirements of the exchanges, between which transactions involving great amounts are made in a few seconds.

Few people, even among those who use the telegraph freely in ordinary business, realize that in the stock exchanges of London and New York half a dozen of the leading speculators sit constantly during the session at the operator's elbow, exchanging messages in 10 seconds; and even the initiated must wonder at this feat when it is understood that these messages are re-transmitted by hand at each end of the Atlantic cable. The exchange business of the entire country is conducted on similar small margins of time, and for this work no telephone, automatic transmission, or any other conceivable method can compete with the key and sounder. A message can be sent by key, clicked off on the sounder, and written down letter by letter, ready for delivery in the time that would be required to *prepare* it for transmission by an automatic system, and even more quickly than it can be spoken through a telephone with any degree of certainty. The telephone's thin piping voice will never buy and sell stocks, or wheat, to any large extent, or despatch trains on any busy section. Speed, accuracy, and record are imperative requisites for such work.

This much being conceded to the Morse system, it may, on the other hand, be stated that to attempt to limit the use of electrical communication for all classes of work to hand transmission would be dense folly. As well might the city of New York insist upon supplying its citizens with water from hand pumps at Croton lake, each ward having a separate pipe and pumper, and each pipe having a capacity fifty times greater than the capacity of the pump. Every telegrapher knows that the limit of hand transmission has been reached, and that, while fast-sending tournaments have pushed up the record two or three words per minute during the last decade, the average speed of working has not increased during the last 20 years. Indeed, it is claimed by many that, owing to the smaller wages paid by the companies, telegraphy has gone backward, both as to speed and quality. The use of the type-writing machine in lieu of the pen, it is claimed, has been beneficial, especially for presswork, admitting code words and abbreviations which are written out in full by the type-writing operator. This, however, is of comparatively small importance. The operator has done his best.

It is pretty well settled that the telegraph companies cannot go on increasing the number of wires. They themselves admit that in future increase of facilities will have to come either through automatic working or through a further multiplication of circuits derivable from a single wire, and of the latter there is little hope.

The British post office recognized the inadequacy of hand telegraphy more than 20 years ago, and put in operation the Wheatstone machine system. Beginning with a speed of about fifty words per minute, the telegraph department, with praiseworthy persistence in the direction of higher speed, has gradually improved the system, until now it is carrying an enormous amount of traffic at speeds ranging from one hundred to four hundred words per minute, according to distance and the character of the conductor. The system is also worked duplex, but at speeds less than double the simplex speeds.

The Wheatstone system was introduced into this country about 10 years ago, and, although it has not been extended as rapidly as might have been expected, it is firmly established on several of the most important routes, notably from New York to Chicago. Over this circuit seventy-five words per minute duplexed, or one hundred and fifty words in all, are obtained. An automatic repeater is used at Buffalo, as through working is not practicable over the present wires.

Now, while the Wheatstone system is a great advance over the hand method for heavy traffic, it can never, in the nature of things, be the telegraph of the future,—that is, if the great bulk of correspondence is to be carried by telegraph. The main obstacle in the way is the electro-magnet of the receiver. The speed at which, with a given pressure, an electro-magnet can be made to move an armature through the required space, and with sufficient power to make ink marks on a tape, depends mainly on the sum of these hindrances,—resistance, electro static capacity, and self-induction. It is safe to assume that the British post office has not stopped short of the highest efficiency possible in dealing with these matters, and that the work of the Wheatstone system in England at present is not likely to be improved upon to any important degree. It must be plain, therefore, that, taking it at its best, this system falls far short of the speed necessary for rates sufficiently low to popularize the telegraph as a corresponding medium.

Giving the Morse and Wheatstone systems full credit, it is my opinion that the system for carrying the mass of correspondence now carried by mail will be one employing automatic transmission, and chemically-prepared paper for reception of signals,—a system having no electro-magnets, no armatures or movable parts, no springs or contacts to adjust, and no inertia to overcome, and one that is not thrown out of adjustment by slight changes of the circuit. The chemical plan of recording is based upon electrolysis. The saturated strip of paper forms a part of the circuit, and its sensitiveness for speed is at least twenty times greater than that of any electro magnetic recorder.

Davy is credited with the discovery that the passage of an electric current through paper moistened with certain chemicals would leave a

mark in the track of the scraping finger under which the paper ribbon was drawn. Alexander Bain was the first to use this discovery for recording telegraphic signals. His automatic system of about 40 years ago met with some success, but it had numerous defects, both mechanical and electrical. The perforating machine for preparing the message for transmission was crude, slow, and unreliable. "Tailing," or running together of the signals, making it difficult to separate the dots from the dashes, was the chief electrical difficulty.

During the past 25 years chemical telegraphy has at different times engaged the attention of numerous able inventors, and considerable progress has been made towards overcoming the difficulties in the way of complete success. Humaston, Grace, and Anderson applied much ingenuity to the development of perforating machines, while Edison, Little, and Anderson have done much in the direction of remedying the baneful effects of "capacity" and retardation, of which "tailing" and "clipping" of signals are the results, by the use of self-induction derived from electro-magnetic shunts and the use of condensers. By these means the speed of working with chemical telegraphy was almost doubled, but, even with these advances, there was still much to be desired.

Improvements of the perforating machine were to a large extent neutralized by more complicated mechanism and greatly increased cost of construction. Experience shows that, no matter how efficient such a machine may be in expert hands, it can never come into general use. For cheap telegraphy the perforating machine must be simple, reliable, and of low cost,—an instrument requiring no mechanical knowledge whatever, on the part of the operator, to keep it in working order at all times,—as simple, for instance, as the typewriting machine, the wonderful popularity of which is due mainly to this feature. In mechanics it seems to require but a very small draft on expertness to exceed the limit of popular ability.

Recent improvements in the perforating machine, transmitter, and receiving instrument for automatic chemical telegraphy have at last brought this ideal plan of rapid communication to a degree of perfection which cannot fail to bring about sweeping changes in transmission of correspondence in general. Between New York and Philadelphia over a copper wire weighing 300 lbs. to the mile three thousand words per minute can be recorded perfectly, and, with a copper wire weighing 850 lbs. to the mile, one thousand words per minute can be carried from New York to Chicago. It is between such large centres and over such long distances that the importance of such an achievement can be appreciated. The field for such a system lies between the present telegraph rate of, for example, 40 cents

for ten words from New York to Chicago, and the letter by rail, occupying nearly 30 hours, for 2 cents. At a speed of one thousand words per minute over one wire, it is estimated that a fifty-word message can be perforated in New York, transmitted automatically, type-written, and dropped in the post office in Chicago at an actual labor cost of 3 cents, to which the cost of the stamp must be added. Two wires of the character named, worked to their highest capacity, would carry all the letters now exchanged between New York and Chicago, provided their average length is not more than fifty words, and all the messages handled by the telegraph companies as well.

The telegraph lines of the future will be in keeping with their importance as means of communication. Iron poles, set in cement foundations, like the best trolley lines, large copper wires, protected above and below by steel guard wires of great strength, and undisputed right of way over shortest routes will be the main characteristics of the mail-carrying lines. The guard wires will be used for way stations and test offices. The copper conductors will carry through-business by the fast system. When it is once proven practicable to deliver one thousand words per minute in plain Morse characters over a circuit 1000 miles in length, all prejudices hedging about old systems and methods of handling business should be swept aside. A perforator and a type-writer will in effect be a sending operator and a receiving operator, and about forty will be employed at each end of a single wire. Can it be doubted, then, that in the near future the telegraph will be the medium of general communication? Great changes have already taken place in the comparatively modern methods of correspondence. To realize this, it is not necssary to go back to the postboy on horseback, the packet boat, or the stage coach. As late as 20 years ago nearly every business man wrote his own letters, and very bad chirography jogged along by mail train at 20 miles an hour. Now, probably over 90 per cent. of the business letters are dictated to stenographers, and plain type-writer print speeds along at 40 miles an hour. The letter of the future will be dictated to a stenographer, who, instead of type-writing it, will perforate it on a paper tape. This tape will be sent to the telegraph office, where it will be put through the automatic transmitting machine, and in a second or two it will be at its destination. The receiving tape will be delivered direct, and the plain Morse characters will be translated on the type-writing machine by the correspondent's stenographer. Commercial houses having a large business will do their own perforating and translating, thus securing important reductions from the regular tolls. For them the telegraph company will be simply a carrier, having nothing to do with their correspondence but putting it through the machine. Nor will such messages be read by any of the companies'

employees, any more than open letters are now read by postal clerks. This will practically render all such correspondence secret, as the perforated strip may be withdrawn as soon as it has been used. The contents will not be forced upon the notice of the telegraph operator as at present. Newspapers, railway companies, or other large corporations which now frequently have to resort to ciphers and codes to prevent "leakage" will welcome this privilege of protecting their secrets. A few weeks' practice is all that is necessary for learning to read the Morse characters with great facility from the paper tape, and proficiency on the perforating machine may be reached in the same time, so that to the already varied accomplishments of the type-writer will be added perforation and translation of telegraphic correspondence. Translation from Morse characters will be easier than from stenographic notes, with none of the elements of doubt attaching to the latter. This reference invites a digression. Is it not time that boards of education took under consideration the advisability of substituting the study of Morse alphabet and the use of the type-writing machine for some of the courses of doubtful utility now maintained in public schools? The language of dots and dashes is the only real volapük, the universal sign language, a knowledge of which would enable a deaf mute to make himself understood from Kansas to Khartoum wherever he found a telegraph operator. If, as it would seem, all commercial correspondence is to involve stenography, type-writing, and telegraphic characters, why limit instruction to penmanship?

Speculation as to the future of the electric telegraph would be within extremely narrow bounds if the question of government control was not considered. It may be somewhat remote, but it is hard to avoid the conclusion that the government will not always draw the line as to the vehicles to be employed for carrying its mail. It now uses over three thousand railway cars on 150,000 miles of road, and keeps six thousand clerks on the move, traveling in crews 140,000,000 miles a year, during which time nine billion pieces of mail matter are handled. About three hundred mail cars are wrecked, a dozen clerks killed, and one hundred and fifty injured during the same period. The total expense of the postal service is about $75,000,000 per annum, and the department is not far from than self-sustaining. How can so vast a system ignore the difference between railway and electrical speeds? A car travels 40 miles an hour, a current 200,000 miles a second. The automatic chemical telegraph will send a message of sixteen words from New York to Chicago every second, and fifty words—about the average of a business letter—in 3 seconds. If time be reckoned as the basis of value for correspondence, which will appeal most to the business man,—a letter occupying 24 hours in covering 1000 miles for

2 cents, or a telegram going the same distance in 3 seconds for 15 cents? Would not a very large proportion of business communications warrant the extra 13 cents? Could a man using the train mails compete in business with another using the the telegraph? Not any more than a man traveling by canal could rival another going by the limited express.

Neither the constitution or any act of congress places limit or restriction on the mode of mail-carrying. The giant proportions and rapidly-increasing power of telegraph interests of late years, coupled with the difficulties presented by the political aspect of the case, doubtless account for the fact that to-day the United States is the only country that does not control its telegraphs. Other governments took them over in comparative infancy, when it was an easy thing to do, and telegraphy has thus become engrafted into their general schemes of communication. The use of the telegraph in many countries of prominence is much more general than in America, notwithstanding the fact that nearly all the improvements—notably Hughes, Printer, the Duplex, Quadruplex, and Synchronous Multiplex systems in their practicality—came from America. The British post office, without prejudice or jealousy, took all these in their turn, and concurrently developed their own Wheatstone system, until to-day, for reliability, accuracy, and uniformity of time, its telegraph service is unequalled.

The British telegraph has not paid its way. It almost reached the maintenance point a few years ago, but the telephone inroads on its business became too great. The deficit is attributed mainly, however, to the enormous amount of press reports carried at very low rates. At night, the first charge of a shilling on a hundred-word message having been paid, the message may be duplicated as many times as desired to any part of the United Kingdom for 4 cents.

In foreign countries, as with ourselves, popular rates have not been available, owing to slow methods of operating; but, now that automatic working is supplanting the hand system, important changes may be looked for. Already Italy, having introduced the Wheatstone system, is about to try the experiment of 5 cent telegrams.

It seems inevitable that sooner or later in this country the government will use the telegraph, either in a monopolistic or a competitive way. It cannot go on restricting the postal service to hauling of actual paper by rail. Among other of its beneficent aims its mission is to place its people in communication by the quickest means at the lowest cost, and for this purpose the telegraph alone will answer. There can be no more striking example of the public desire for quick facilities of communication than is shown in the avidity with which they have taken advantage of the quick-delivery system instituted by

the post office a few years ago. Every such letter is an evidence that the writer is willing to pay 10 cents in order to expedite the delivery of his letter half an hour. If these letters could be telegraphed for, say, 15 cents, or 3 cents more than the ordinary and extra postage, no one can doubt that nearly all would go that way.

Mr. Delany's strong presentation of the argument in favor of government ownership of the telegraph systems offers an excellent opportunity for the presentation of the other side of that important question. The following editorial from a recent issue of *The Journal of Commerce* of New York, speaks for itself.—THE EDITOR.

The post office department is the stock example of efficient government management invariably cited by persons who desire to enlarge the field of public and restrict the field of individual enterprise. The financial statement of the New York office, just issued, will assist one to understand how little the management of the postal service warrants a general extension of the functions of the government in the field of transportation, construction, and production.

The total receipts of the office in this city in the late fiscal year were $7,264,984, and the total expenses were $2,972,126, including nearly a million and a third for the free-delivery service; this afforded to the government a net profit in operating the post office in this city of $4,282,857, or about four-sevenths of the gross receipts.

The first reflection suggested by these figures is that the profit was extortionate. No business open to competition can make anything approaching this rate of profit. If the government would withdraw from the field, or would at least waive its monopoly, private companies would render the service for half the present scale of charges, and would expedite the service and would assume responsibility for losses,—a thing the government will not assume, even when its customers pay a registration fee. So far as this city, and in fact this section of the country, goes, it is suffering from a monopoly which in private hands would not be tolerated for twenty-four hours. Repeated efforts have been made to evade the government monopoly and carry letters in this city at a one-cent rate. Private companies would jump at the chance of collecting letters at people's houses and offices and delivering them for one-half the charge made by the government, but the government monopoly is securely guarded, and we must pay more than double what the service costs.

The government, however, makes no profit on its postal service. It carries letters and newspapers on the philanthropic principle on which the Populists desire it to carry wheat and corn and cotton. There are a few States in which the government makes a profit out of its post office. But in the great majority it does its postal business at

a loss. The profit made in New York is used to fill the deficit in the postal business of many western and southern States; not every eastern State, even, shows a profit for the post office. The government exercises the right of charging vastly more than private carriers would for doing a postal business here, and of using the profit to enable it to do a postal business in Nebraska for very much less than any private carrier would,—for much less, in fact, than it costs to do it.

This is a process of equalization which doubtless meets the approval of many persons in the west and south who cannot imagine any reason why the east should not be taxed for their benefit, and who argue plausibly that the east makes money out of the other parts of the country, and should meet a good part of the expenses of carrying on the other parts. But the philanthropy of the post office does not stop here. It does not have to live on its income. It is in the happy position of the young man who earns what he can, but whose unpaid bills are annually settled by his indulgent father. For the current fiscal year the appropriation for the postal department is $89,545,997, made up of all the revenues of the department and whatever additional sum may be needed to meet expenses. This is estimated to be two and a half millions, but is quite likely to be more, for the appropriation is a million and a half less than the estimates of the department, which is very well informed as to its liabilities. The deficit is made good out of money raised by taxation. The postal service is conducted at less than cost to the people who use it, but the deficit must be made good from some quarter; it is made good out of other people's pockets, or out of the pockets of the people who use the post office, but at times when they do not know what they are paying for. A man gets a letter carried for one cent less than the cost; and then, for every five glasses of beer he drinks, the government takes a cent out of his pocket to make good the cent it lost in carrying the letter.

The political importance of rapid communication between all points in the country is sufficient to justify the government in carrying letters without profit, and even at some loss; the deficit will never become unmanageable. But, if it did a telegraphic service on a like plan, the aggregate deficit might become serious, for the postal deficit has been seven or eight millions. The fact that the government charges nothing for the service of carrying country papers within the county of publication in order to conciliate the "palladium of our liberties," though it has to pay for this as for any postal service, affords a glimpse of the dead-head service that would be exacted of the government by political influence, should the government extend its philanthropic operations to the telegraphic field, the railroad field, or the factory field. It is well known that much of the financial embarrassment of

the Australian colonies is due to the fact that, to please this constituency or that, the colonial governments have extended the railroads, nearly all of which are public property, or reduced charges below the cost of rendering the service. There is now at large in this country a Californian named Lubin, who is trying to get people to demand that the government shall defray a part of the cost of shipping grain abroad. This cost cannot be eliminated, though the ordinary competition of trade has wonderfully reduced it. But whatever the government disburses on that account it must get from somewhere; it must raise by taxation. Probably the farmer is quite willing that the cost of exporting his grain shall be paid by some one else. But it is quite clear that every one cannot get his expenses shouldered off upon some one else. If those who dance do not pay the piper, the "wall flowers" must, and it is not likely that they will long consent to.

That the government does the postal service economically is a common assertion which will not bear any examination. In the populous east it charges a rate which yields profits that only the most avaricious and successful trusts ever dreamed of. No private company was ever robbed on its contracts as the government was in the days of "star route" frauds, and, though these days are over, no one familiar with the contract office of the post office department will pretend that the government gets this branch of mail-carrying done as cheaply as express companies would. Far the largest item in the cost of the postal service is the payment to the railroad companies, the rate governing which has not been reduced for seventeen years, though, for all other services rendered, the railroad companies are getting much less,—in fact, not much more than half. Monopolies as they are said to be, the railroad companies have reduced their passenger rates and their freight rates in the most radical fashion, while the government goes on paying the same rate per hundred pounds for carrying postal matter that it paid seventeen years ago; and it is paying to the large railroad companies, which carry the heavy mails, a rental for the use of postal cars which annually exceeds the cost of building the cars, and which is additional to the payment by weight.

Instead of justifying an extension of government activities in transportation and production, the facts of the postal service constitute a warning that the nation would be bankrupted in five years if the government undertook to carry on the freight business upon the principles which govern the carriage of the mails.

THE NEWHOUSE TUNNEL AT IDAHO SPRINGS.

By Arthur Lakes.

AMONG great tunnel enterprises the Nesquehoning, Musconetcong, Hoosac, and Sutro, in America, and the Mt. Cenis and St. Gothard, in Europe, are familiar. The Rothshönberger Stollen tunnel in Saxony is an example of old style and of German perseverance. Of these the Sutro and Rothshönberger Stollen are most akin in purpose to the one which is the main subject of this article.

In Storey county, Nevada, rise sa great mountain chain, the Washoe range, its peaks reaching 7800 ft. above sea line. Of these Mt. Davidson consists of syenite, and overlying the vein are augite and hornblende porphyries. The width of the lode is from 50 to 100 ft., and sometimes very much more. Even in the early and most prosperous days of the mine it was considered that it would be advantageous and necessary in a few years, for the continuance of mining, to tap the lode at a greater depth by tunnel. Before the tunnel the ore, refuse rock, and water were raised to the surface through the shafts by steam power, and the ore transferred to mills by wagon and rail.

In 1860 Mr. Adolph Sutro conceived the plan of driving a deep tunnel to the Comstock lode. In 1865 the legislature granted a franchise of right of way. The other mining companies working on the Comstock lode agreed to pay a toll of $2.00 per ton on every ton of pay ore after the completion of the tunnel.

Congress, by the "Sutro Tunnel Act," gave Mr. Sutro:

1. The right of way to run a tunnel 7 miles in length to and beyond the Comstock lode and a north and south drift on this vein and all others found on the line of the tunnel.

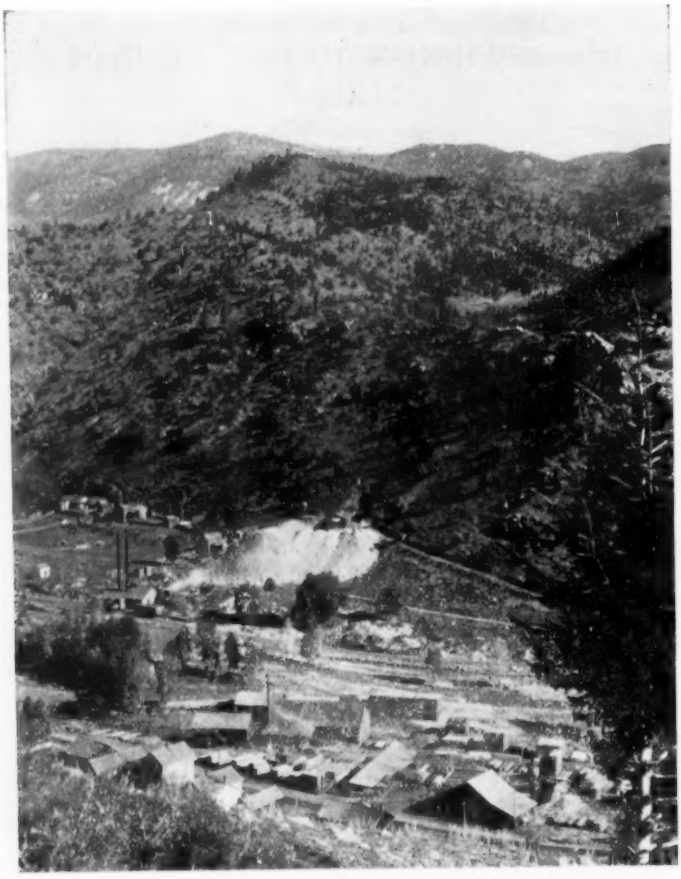
2. The right to sink shafts on the line of the tunnel, and to purchase public land in connection with the tunnel at $1.25 per acre.

3. The right of acquiring at $5 per acre all veins which occur inside a distance of 2000 ft. from the tunnel, except those already in possession of other parties.

4. To levy a royalty on mine owners, in consideration of the drainage and other advantages, on the completion of the tunnel.

Between 1860 and 1878 the Comstock produced $291,341,026. Its total product up to to day is more than $325,000,000.

Mr. Sutro's scheme was to make the tunnel a main artery, from which branches should extend thoroughout the entire mining district,



NEWHOUSE TUNNEL, GENERAL VIEW.

which has a width of 8000 ft. and a length of 5 to 7 miles. This it was proposed to cross-cut at intervals, and re-cross cut, thus finding all bodies of ore in the district; also to supply cheap transportation, drainage, and other facilities.

The tunnel, starting from Carson valley, penetrates the rock 20,000 ft. and strikes the lode near the middle of its productive portion, 1900 ft. below its highest outcrop. The rocks encountered were hornblende-andesite, augite-andesite, diabase, and diorite.

The greatest depth reached by shaft was 3000 ft. Intense heat prevails in the lower levels, and much hot water is found there.

In July, 1878, connection was made with the Savage mine at 20,000 ft., and a strong draft set in at once. In September, 1878, another mining drift was encountered, and in October a third. In January, 1879, connection was made with four more shafts.

In September, 1872, the first attempt at machine drilling was made, and 542 ft. of holes drilled in 30 days by the Burleigh drill. Dynamite was first used in 1870. Six drills were used in the face.

The Sutro, as typical of the introduction of the new style and appliances, and the Rothshönberger Stollen, as typical of the old style, are worthy of comparison. The latter was commenced in Saxony in 1844 and opened in 1877. All but the last few hundred feet were driven by hand labor, without any of the modern appliances. The best average attained was 279 ft. per month. The length was 42,366 ft. The deepest point reached was 308 ft. below the surface. With all its branches completed there will be about 31 miles of tunnelling,—the longest tunnel in the world. The cost up to 1874 was $1,500,000, or about $51 per running meter.

This long tunnel gains a depth of only 308 ft. below the Anna mine adit, and connections with other mines give a drainage of only 499

IDAHO SPRINGS, LOOKING TOWARD TUNNEL.

STARTING THE TUNNEL. HAND DRILLING.

feet. The object of this tunnel is the same as that of the Sutro, which is 5 miles long and meets the workings nearly 2000 ft. below the surface. "If," says Mr. Devinter, "the economical Germans are willing to spend so much money and time in making an adit 30 miles long for the sake of gaining a depth of but 300 ft. of drainage, it is evident that the days of deep tunnels are not over."

In Utah they are running a tunnel 4 miles long to drain by a few hundred feet the celebrated Ontario silver mine, and this through the hardest of rocks, limestone, and quartzite. In Colorado, besides the Newhouse tunnel, many tunnel enterprises have been carried out, while others are in process. Notable among them is the Yak mining tunnel at Leadville, driven for "custom" and drainage purposes through Iron hill into Breece hill. The scheme was outlined by Mr. A. A. Blow, manager of the Silver Cord mine, in 1890. The tunnel opened into California Gulch, and in 1893 had been completed to the Silver Cord mine. This enabled the managers to handle a large quantity of low-grade ore from this mine, and treat it at the concentrating mill erected at the mouth of the tunnel. From the Silver Cord the company is pushing the tunnel on to pierce Breece hill and the celebrated Leadville gold belt of Ibex fame, and thus open up a number of gold properties by means of an underground

route. The rocks passed through are quartzites, limestones, and porphyries.

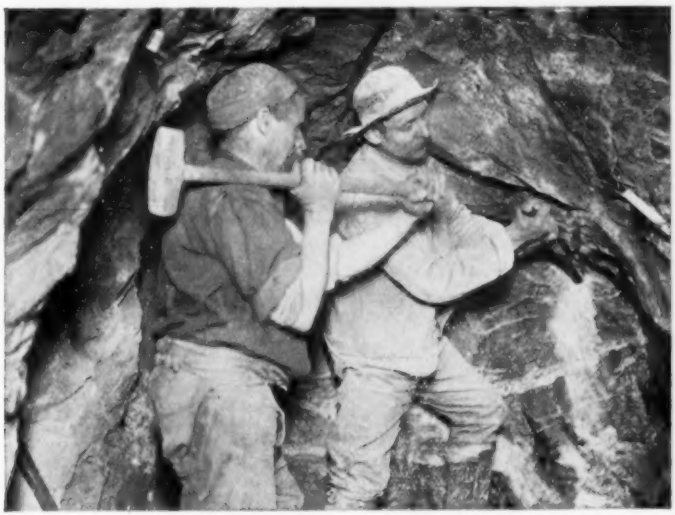
With these examples before us, we may proceed to describe the Argo tunnel, or—as it is more commonly known, from the name of its enterprising projector, Mr. Samuel Newhouse—"the Newhouse tunnel," at Idaho Springs, Colorado.

Idaho Springs is a pretty little watering place, as well as mining town, 30 miles from Denver in the Front range of mountains. It is situated by the rapid stream of the South Fork of Clear creek, and is as well known as a health resort on account of its mineral and soda springs as it is for its wealth in gold and silver mines.

Central City, on the other hand, is essentially a mining town, situated high up among the mountains, about 4 miles north of Idaho Springs. It is built on the sides and ledges of the cliffs and hills above the North Fork of Clear creek, an insignificant stream affording but a very inadequate supply of water to the mills and mines of Central City, Nevadaville, and Blackhawk, while the South Fork is a powerful stream with an abundant water power the year through.

Between these two forks of Clear creek lie the mining areas of Central and Idaho Springs, which, from a mining point of view, may be regarded as practically one.

On the southern face of this region, ascending from Idaho Springs,



NEWHOUSE TUNNEL. HAND DRILLING.

DRILLING THE SIDE ROUND.

the surface is steep and mountainous, diversified by ravines and culminating on the summit of Mt. Pewabic several thousand feet above the river, from which point a fine view of both the Central City and Idaho Springs areas is to be had. From summit to base the mountain slope is dotted with mine openings and prospect holes, following certain roughly parallel lines indicating the outcrops of a series of parallel fissure veins. These veins the Newhouse tunnel expects to cut at considerable depths, at right angles to their general strike or direction. From the top of this mountain, forming the dividing ridge between the two mining districts, we look down in a northerly direction on a country of rolling hills and open valleys, which continues as far as the cañon of the North Folk, along whose banks string in a long connected line the mining towns of Nevadaville, Central, and Blackhawk,—towns whose streets and houses are undermined by many tunnels and shafts, while the noise of ore-crushing mills but ill supplied with dirty water fills the air, indicating the mining activity of the vicinity. This part of the section (in Gilpin county) is even more honeycombed with mines and prospect holes and dotted with mining dumps and shaft houses than the Idaho Springs side, impressing us with the fact that the whole region is underlaid by a vast network of gold and silver veins, many of which have produced ore continuously for the past 30 years.

The geology of the entire region is simple. The rock is mainly mica-schist and gneiss of a granitic type. In the general uplifting and folding of these mountains a series of more or less parallel fissures were

formed, extending for some miles across the country and descending to depths far below the reach of mining operations. These fissures were filled with quartz and feldspar veins, carrying also a certain percentage of gold and silver, principally the former. The experience of 30 years has shown in the deepest mines—such as the California, over 2200 ft. deep—that richness rather increases than diminishes with depth. Accompanying the uplifting were eruptions of molten porphyries through fissures now traversing the region as long dikes. These porphyries are the common accompaniments of our mineralized regions.

The great number of mineral veins in this region is shown by the section of those already well known and developed that lie in the path of the projected tunnel; also by the books of the United States surveyor general, who reports 1400 mineral claims patented in Gilpin county alone, with a large number on the Idaho Springs side. There is no doubt that, in addition to these, there are a great number of as yet undiscovered veins lying in the intervals between them, obscured on the surface by brush and *débris*. These "blind veins" will be discovered by the Newhouse tunnel in its deep workings, and will become its property. The development of these will add to the revenue of the tunnel. The Newhouse tunnel proposes to undermine at an average depth of nearly 2000 ft. a mountain of gneiss and schist 3¾ miles in diameter, traversed by an unusual number of parallel fissure

QUARTZ HILL. MINES ON LINE OF TUNNEL.

MINED-OUT STOPE.

veins carrying gold and some silver, the richness of many of which has been satisfactorily proven.

According to the prospectus of the tunnel, "its purpose is to discover, cross-cut, drain, and operate at greater depths than is otherwise feasible, lodes of gold and silver, and to offer working facilities to mines discovered hitherto, and to afford an outlet and milling facilities to all at a minimum of cost."

The gold belt of Gilpin county has already yielded about $65,000,000, mostly in gold. Its annual production has occasionally exceeded $3,000,000. The largest producing mines have been worked continuously for 30 years. These mines vary in depth from a few hundred to 2200 ft., with no sign of exhaustion.

The arrival of the tunnel to these mines will be an enormous help to them, especially in getting rid of the water with which many of them are at present overburdened. Thus it is estimated that, while thirty-six of the leading mines have produced $53,000,000, they have expended over $6,000,000 in hoisting and pumping and in sinking 73,000 ft. of shafts. One mine for many years raised on an average 40 tons of water for every ton of ore and rock. As I write, news of an appalling accident, verifying the use of the tunnel, comes to me. Sixteen miners have just lost their lives at Central city, the water of one of the mines breaking in on two other mines. Such an accident could not have occurred had the Newhouse tunnel arrived at the spot.

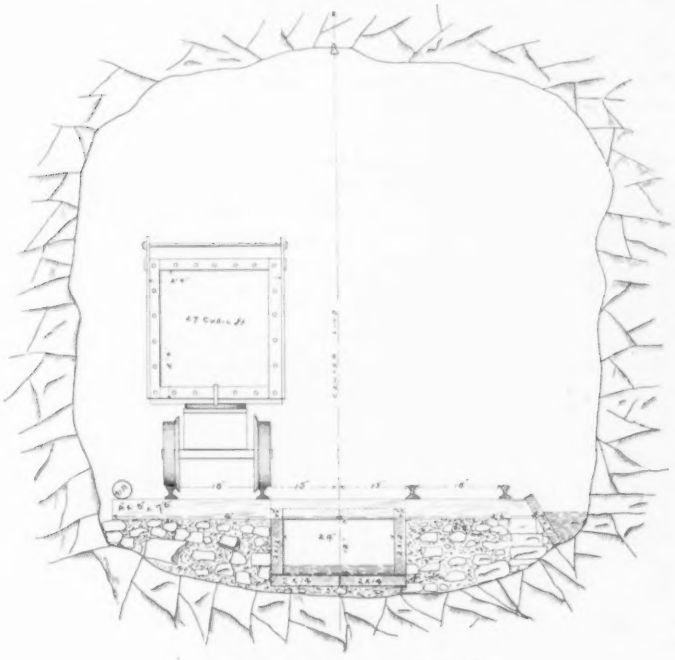
To sum up. The Newhouse tunnel will cut through virgin ground, in an old gold-mining region of wide extent and reputation, a great number of lodes yielding pay ore at great depths.

It will afford the cheapest method of working these mines. Thousands of tons of low-grade ore now lying idle in the mines and on the

dumps will be handled at profit by the tunnel, subject to its tariff. Enormously expensive machinery operated by steam at great cost will be no longer needed. Great shafts to accommodate pumping and hoisting machinery will be no longer necessary. A natural drainage and ventilation system for the district will be established, inexpensive to maintain, subject to tariff and lucrative to the Argo Company.

The following notes descriptive of the construction of the tunnel were given to me by Mr. Walter H. Wiley, E. M., the mining engineer in charge of the development of the tunnel, who also personally made the photographs accompanying this article.

The tunnel is 10 ft. wide by 9 ft. high, with double track of 18-in. gage and a space of 30 in. between the tracks. Beneath this central space is a wooden drain 2 ft. wide and 14 in. deep, the top of the drain, even with the top of the ties, forming a foot-path. This box, as the flow of water is now small, is also utilized to convey the foul air out by means of an exhaust fan at the entrance of the tunnel. The



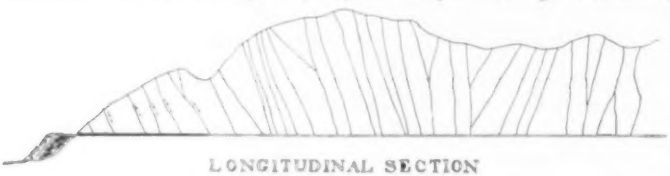
CROSS SECTION OF TUNNEL IN ROCK.

MINE DRIFT. HAND TRAMMING.

first 80 ft. are timbered with square 10-in. timbers, forming an arch overhead. For the rest of the way the rock is so firm and massive that no timbering is needed.

The rails weigh 30 lbs. per yard and are laid upon ties 7½ ft. long, which on one side are laid with the end close to the rail to allow room for an open side drain. The grade is 5 in. in 100 ft. At intervals of about 1000 ft. short cross-cuts are run in the sides of the tunnel, to which the workmen retreat when blasting takes place; and in the one nearest the heading is the battery with which the shots are fired. The character of the rock is gneiss, frequently much banded with mica or hornblende; sometimes crossed by large bodies of pegmatite, sometimes passing into mica-schist, and occasionally into a very hard, tough, black hornblendic rock. Two dikes of porphyry have been crossed. Also quite a number of small interstitial veins or veinlets, sometimes in a network and showing little faults and small movements, and crossing and re-crossing one another. They are mostly little quartz seams, with iron pyrites, bounded on each side with a dark reddish band of hematite formed by the oxidation of the pyrite.

Water trickles in at several points, with much iron oxid stain, which suggests that it comes from some ore body, perhaps of importance. The tunnel, at the time of my visit, was in about 3000 ft. The straight line of the tunnel is maintained by a surveyor, who has wooden plugs with screw eyes driven on the exact center line in the roof. By alignment with lamps suspended from these points the exact center is determined in the heading every day. This point being ascertained,



LONGITUDINAL SECTION

THE NEWHOUSE TUNNEL.

the workmen at the face paint a vertical center line down the heading, and commence work on either side of this. The drilling is done with two 3-in. cylinder, Leyner power drills, working day and night. The holes are drilled, usually five on either side of the center line and four or five nearer the sides of the tunnel. The first holes converge inwards, and the center is blasted, first taking out a wedge-shaped mass. The drilling is begun with a short drill about 2 ft. long, the point 2¼ in. in diameter; longer drills follow, the point of each of less diameter than the preceding one drilling a hole shaped like a telescope looking toward the eye-piece. The center-cut holes are 8 to 10 ft. long; the side ones, 6 to 8.

Dynamite is used,—100 to 175 lbs. each round. The ½-lb. sticks of dynamite are lowered into the hole, as many as sixteen sticks at a time, and firmly tamped by a piece of gas-pipe with a wooden plug in the end.

The 9 ft. holes are filled 6 ft. with dynamite, and the remainder of the hole to the top is filled with cartridges of fine dirt ready prepared. Prior to the tamping, the exploder is inserted, firmly imbedded in a stick of dynamite. This exploder is a small copper cap about 1 in. long, filled with fulminate of mercury. To it are attached two fine copper wires, one negative, the other positive, both thoroughly insulated with a rubber covering.

TRAMMING. MOUTH OF NEWHOUSE TUNNEL.

TIMBERING.

These wires come out of the drill hole at the side of the tamping. The wires from the different holes are united. Then one on each side is connected with the main leading wires from the battery. The last 50 ft. of the main wire are of a smaller and cheaper kind, and most of this is destroyed at each explosion.

The battery stands safely in a short cross-cut, some hundreds of feet from the heading, and to this cross-cut the men retreat before each explosion. When all are under cover, the arm of the battery is raised, rapidly lowered, and all the holes connected are exploded simultaneously. Previous to this, the drills are removed to a place of safety. The powder smoke fills the recess, and the men wait from 10 to 20 minutes before returning to the heading.

After the center-cut, the side round is blasted, and then a gang immediately begins to clear away a space at the heading for again setting up the drills; after this the broken rock is trammed out to the dump in train-loads drawn by mules.

In all, twenty-six men are employed, divided into two shifts of drill men and three for handling the rock. The ventilation fan is a Huyett and Smith No. 11 exhauster,—the blast wheel 26 in. in diameter, driven two thousand revolutions per minute by a 20-h. p. engine. The powder smoke and foul air are exhausted through the drain box before mentioned, which also carries the water, discharging through a trap at the outlet.

The compressor plant is in duplicate, consisting of two Norwalk compound 14 × 16 high-altitude compressors and two 80 h. p. boilers.

MOUNTAIN RAILROADS OF THE MINING REGIONS.

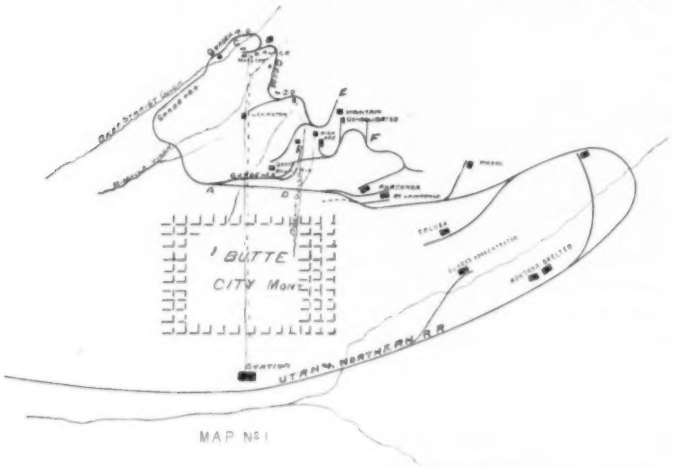
By James R. Maxwell.

THESE may be divided into two classes,—those built solely to serve the mining interests, and those built mainly for general work. Great care should be taken in the location of these roads. Too often hurried work is done, and in many cases directors would be surprised to learn how much such haste has cost. Changes can be made even after the grading has commenced. They may extend over many miles, and result in large saving, or in improvement of the alignment, and sometimes, happily, in both.* Or many times on a small scale, by changing the rate of a curve, or moving it ahead or backward, or swinging a tangent, a few degrees of curvature may be thrown out, or a cut or fill diminished in quantity.

Years ago an eminent engineer said to the writer: "A location should never be considered final until the work has gone so far that no more changes can be made profitably." That saying should be a rule for all new railroad work. Lines built solely for mining interests are usually projections or spurs of other roads, generally short, with heavy grades, and curves. An example of this class is shown at Butte, Montana, where the Union Pacific Railway was called upon to furnish transportation for the copper ores from the mines to the smelters over 30 miles distant. Butte station was in the bottom of the valley; the town and mines on the hillside to the north. Most of the mines were above the town. The extension was made to serve the now famous mines of the Anaconda Company. The grade required to reach the first of them (on the Anaconda vein) was 2.8 per cent., compensated for curvature at 0'.05 per degree of curve. On a later extension 4 per cent. was used. The maximum rate of curvature was fixed at 14°. Spurs were made to all the hoisting works, and, where possible, two to each,—the upper one to deliver material, the lower to carry away ore. The first to be finished was an ore spur to the St. Lawrence mine; the second served as an ore track to the Anaconda, and was extended so as to pass above, and deliver material to, the other mine. After these were finished, the mining company acquired large interests, on a parallel vein, farther north, and extensions were made to the hoisting

* An instance of this kind occurred in one of the territories some years ago. The road was well located; still, there seemed to be chances for improvement, and surveys showed that a saving of 124° in curvature, over a mile in distance, and about 60,000 cu. yds. of embankment, could be made by a bolder location.

works thereon, as well as to some belonging to other parties (see Map 1). One of these ore spurs was thrown off on the right, on a descending grade, and passed under the line it had left. It crossed by a tangent



MAP No 1

under a trestle, built on a maximum curve. The intersecting angle was 30°.* The spurs were also planned as impediments in the way of any other company that might desire to share the traffic. Each spur was on a level tangent at the ore house, but on a grade throughout the rest

SMELTER NO. I. ANACONDA, MONTANA.

of its length. The spurs on the lower side descended in the same direction as their main line, but the others were switchbacks ascend-

* The spur to the Colusa is also on the down grade; those to the St. Lawrence and the Anaconda are on ascending grades.

ST. LAWRENCE AND ANACONDA MINES, MONTANA.

ing at the maximum rate of grade. Wooden trestles were used in crossing most of the large ravines, the intention being to fill them up later with waste material from the mines, if the camp held out long enough to warrant this. There was very little earth or other loose material available for borrowing. On the lower part of the work, the water of two mining ditches, and the discharge of some of the large

ON THE A. & P. R.R. NEAR THE SUMMIT OF THE ANDES.

gulches, were carried under the embankments by cast-iron pipes, but on the upper portion the culverts were made of heavy planks.

The smelters were built at Anaconda, a town laid out where this company owned a large tract of land and valuable water powers. It was reached by a branch from Stuart, a station on the Montana Union Railway, about 20 miles from Butte.* This branch has light work and moderate grades, but on the extensions, and spurs to the ore houses, the work is heavy, with steep grades and sharp curves. Many of the latter are of the maximum rate. The maximum grade used was 4 per

AREQUIPA, PERU. VOLCANO OF MISTI IN THE DISTANCE.

cent. The upper tracks were to the ore houses and calciners, the middle ones to bring in coal and wood, and the lower ones to bring the other supplies and carry away the product. The smelters were built on a steep hillside, with the machinery placed in steps, so that the ore would descend by gravity from the ore houses to the crushers, thence to the concentrators, and finally to the smelting furnaces.

The approach to the first ore house was over a high trestle, on which the maximum grade and curve were used. The necessary change of grade and line before entering this house produced a curious-looking warped surface on the track.

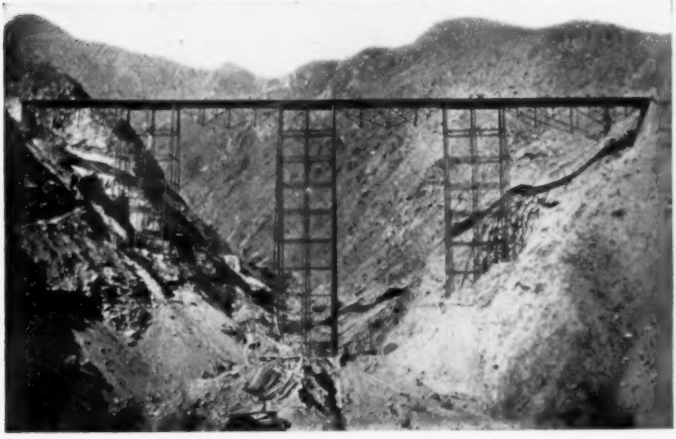
The first plans were made for a daily traffic of 500 tons of ore, with the necessary amount of wood and coal to smelt it. The business increasing, more smelters were built, and 4000 tons of ore, with a corre-

* This railroad connects the Union Pacific system with the Northern Pacific, and was jointly owned by the two companies.

SAND DUNE NEAR LATOYA.

sponding increase in the amount of fuel, were used each day. This caused large additions to the yards in Butte and Anaconda, and led to a change in the line through Silver Bow Cañon. When the road was built, it was good enough for the business in sight, and probably for many years to come; that was before the magnitude of the mines was known. But the business increased until that short piece of line had a much greater tonnage than any other two pieces of the same length on the two systems combined.

The long ore trains were difficult to handle in the cañon, and



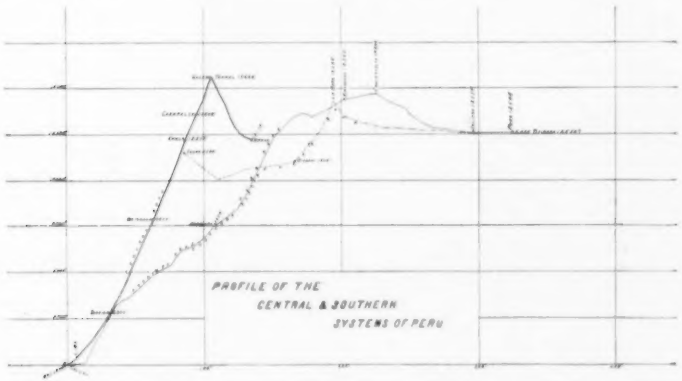
VERRUGAS BRIDGE, 256 FEET HIGH.

ON LAKE TITICACA.

liable to accidents, as the man on the engine could not see those in the caboose, nor they him, until the narrow part was passed; so this was remedied by straightening the line.

Of mountain railroads built mainly for general work examples are furnished in Peru, where a grander mountain range is encountered, and higher altitudes attained, than are possible in this country.

The highest of these, and the highest in the world, is the summit of the Central Railroad of Peru, where it crosses the Andes mountains at the elevation of 15,666 ft. above sea level. Two other summits on the Southern system are above 14,200 ft.* These roads were built by the Peruvian government to develop the country, as well as for military purposes. It fixed the route of each, and the standard according



to which they were to be built. The maximum grade was 4 per cent. compensated on curves of less than 1968 ft. radius, and the minimum radius allowed was 393.6 ft. The contracts for these roads were specified, a lump sum to be paid for each. The contractor located and built them, subject to the approval of the government engineers.

Four of these are mountain roads, all beginning at ports on the Pacific ocean. Of these three were designed to cross the mountains, and to ultimately reach navigable water on some of the branches of the Amazon. The most northern of them, the Pacasmayo, began at that port, and was to terminate at Cajamarca† on the eastern slope of the Andes, with a branch to Guadalupe. The location was easy at first.

* Galera tunnel is higher than any mountain peak in the United States except Alaska, and is exceeded in Europe only by two peaks in the Ural mountains.

†Cajamarca was one of the capitals of the Inca empire. An extension down the valley of the Tungurangua will get to navigable water in less than 300 miles, and make a shorter connection with the Atlantic, and probably have deeper water at the river port, than either of the others.

Leaving the port, it crossed some low desert land, and then ran up a valley to its head; thence by development across the mountains. Before leaving the flat country, a branch was started to the north, to Guadalupe. This approached so near to the coast that a short trail was made, and mule trains competed successfully for the carrying of sugar. It is probable that political influence had much to do with this location. The main line was built to the beginning of the maximum grade; the branch was finished, but none of the mountain work. The summit of this line is the lowest in Peru, as far as known.

Next to the south is the Chimbote road, which was not intended to cross the mountains. The gage of this is a meter;* all the others have a gage of 4′ 8½″. On the ascending grade the heaviest rate was 2 per cent. There is an adverse piece of grade of 3 per cent. that should never have been put in and will be taken out whenever this road is completed. Its initial point is Chimbote, on the bay of Ferrol, one of the best natural ports in the country. From there it runs over about 12 miles of smooth desert to the Santa valley, and then up to Huaraz and Recuay. To the latter town the distance is 165 miles, with a rise of about 11,000 ft. The Santa river is the largest stream in the country on the western slope. It rises on the east side of the Sierra Negra (Black Range), and runs northward between it and the main range, known there as the Sierra Blanca (White Range). About half way from its source, it turns abruptly to the

DEVELOPMENT AT HUSAMAYO, A. & P. R.R.

* The use of the metric system is compulsory on all public works.

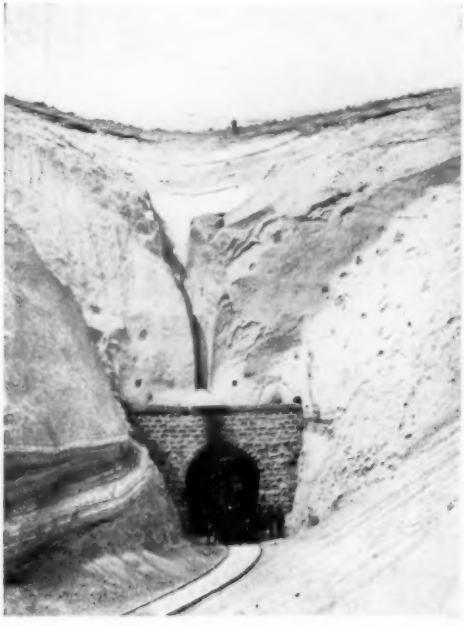
left, and breaks through the Black Range to the Pacific ocean. The cañon thus formed is extremely rugged; so much so that, previous to the advent of the railroad, the people in the upper valley could reach the coast only by crossing over the intervening range through passes more than 16,000 ft. above sea level. In doing this they had to make two dry camps; they carried water for their own use, but none for the animals. The principal article of export was high-grade silver ore.

A. & P. R.R., 25 MILES FROM AREQUIPA.

The location from the port to the valley was by long tangents with a few light curves. In the lower part of the valley were some stretches of tropical jungle each several miles across. This was so interlaced with vines that the cutting of it down was the least part of the work. Progress was very slow in the rugged part of the cañon, especially in one place about three miles long that had never been entered. This was the worst place found on any of the roads. Farther up there is a similar one that has not yet been visited by man. The line and levels were carried over it by triangulation from points high up on the hillsides. The engineer who made this survey said that the walls of the cañon were so steep and so near together that he could see the river only in a few places.

Through the close part of the cañon the work on the preliminary line was very laborious; the climbing required steady nerves, and cool heads were necessary at the instruments. A force was employed to cut

paths, and frequently places for the instruments. Before the locating party got to work, these paths were replaced by a good mule trail. Suspension bridges were used where it was necessary to cross the river. They were an improved form of the Inca bridges, being supported by wire ropes. They seemed very shaky and insecure, but a large amount of travel was made by them, and no accidents were ever reported. The building of these paths and trail formed a large item in the cost of the Chimbote road. The railroad was generally on the left bank of the stream, and the mule road wholly so until near the upper end of the cañon. The camps were mostly on the same side as the trail; but, when the work was on the opposite bank, the men crossed, by means of a rope stretched over the stream, on which ran a single block crarying a boatswain's chair. This method of crossing was agreeable enough while on the down grade, but, after passing the middle, it was not, the jerking causing sensations similar to those felt when standing near the stern of a vessel in a heavy seaway. Where it was impossible to pass over the centre line in locating, some very fine work was done by the engineers in fixing the line and grade points by triangulation. On construction the same methods were used.



TUNNEL. HUSAMAYO DEVELOPMENT, A. & P. R R.

On the lower part of the road no culverts were required, except for irrigating ditches, as there was no rainfall or springs to provide for. The dry clay and sand would stand at a rock slope.*

* The road passed at the foot of a cliff of this kind, where the slope was the wrong way; so the overhanging part was blown off, solely for appearance's sake, no danger whatever from it being apprehended.

Another, and an unpleasant, feature of this cañon was the continual falling of stones, mostly small ones, though occasionally large pieces would come crashing down. When one of these struck the track, it smashed that part very thoroughly. Several fatal accidents to men and animals occurred in this manner.

LEFT ON QUINTALA BY THE TRAIN.

Ten tunnels are built; the upper box cañon will probably require many more. These are in solid rock, and no lining was needed in any of them.

When cliffs were to be blown down, drifts were run in, with a

cross drift at the end, and chambers at the ends of this. This work was contracted for by the running foot: it was surprising to see in what a small hole the men could work. The salient features of this road were the great difficulty and cost of getting into the cañon with the preliminary and location, and to get the men and supplies in while grading. A number of mules were lost by being crowded off the trail by others when they met on a narrow path high up on a hill-side.*

The second Trans Andine road, now known as The Ferro Carril Central del Peru, was completed early in 1893; it extends from Callao to Oroya, a distance of 136.5 miles. From the coast to summit (Galera tunnel) by rail the distance is 106.2 miles; the difference in elevation is 15,656 ft. Oroya is 30.2 miles farther, and over 3300 ft. lower. It is said that there are valleys near Lima that lead up to passes better than Galera: but, for other than engineering reasons, none of these were chosen.

Considering the little time given to the engineers, the road is located in detail remarkably well. The only alternative was a pass at

TEMPORARY TRESTLE USED WHILE RIVETING BRIDGE.

the head of a small valley near Casapalca. From observations and barometric measurements this route seems feasible. If it had been adopted, the tunnel would have been about the same length as Galera,

* The Chimbote road will have a large traffic when the mines of hard coal are reached and a still larger and steadily-increasing business when the upper box cañon is passed.

several small tunnels would have been left out, and about 6 miles in length and 600 ft. in elevation would have been saved.

There was not so much dangerous climbing required here as on the Chimbote road, and the stream was not so difficult to cross, but far higher altitudes were reached; and it makes a very material difference

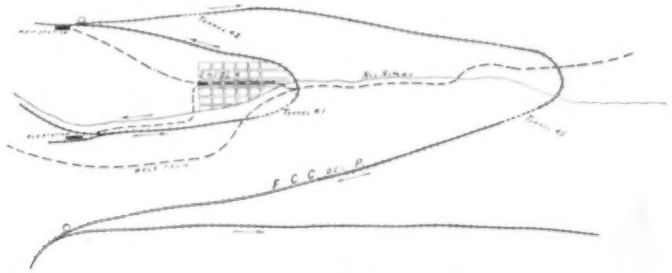
TEMPORARY HOUSE OF INDIANS AT WORK ON R.R.

in the amount of work done, either in locating or grading, whether the barometer is at (or near) 30 in., or gets down below 20.

When the road was located, the only feasible plan of working it seemed to be that of using switchbacks. There are eight of these,—seven of them on the western slope. The largest is at Chicla (see Sketch Plan 2). There the valley rises faster than the maximum grade, but is wide enough to turn in, by using a curve of the minimum radius. Then, after running back as far as the slope of the hill permits, a switch and a turn-table are put in, so that the engine can be turned and taken to the other end of the train. The line runs ahead for about a mile, when another turn is necessary; again it heads down stream, but steadily climbs the 4 per cent. grade, until it runs into a corner, just opposite to the other switchback. There another switch and another turn-table are used, as before, and the line starts once more on its original course.

By this means a gain of over 700 ft. in elevation is made. The characteristic points of this road are the great altitude attained, the large bridges used (some at great heights), the liberal use of retaining walls, and the great number of tunnels.

There were fifty-six when the road was finished,* all except the summit being on the western slope, in a space of 24 miles. Seven of



MAP NO. 2.

these are above 12,000 ft., and nine more over 15,000 ft., above sea level. The summit tunnel (Galera) is 3654 ft. in length, and is one of the few that are on tangents.†

The Southern system consists of three roads, two of which are completed. They are the Arequipa, 107 miles; the Puno, 218 miles; and the Cuzco, with 126 miles of track laid and located, and work done on 84 miles more. The beginning was made at Mollendo. It should have been at Islay, 7 miles farther north. This is a better port, and nearer to Arequipa, but some influence determined otherwise. After that, the line is well located, especially on the Cahuintala development, which rises over 2200 ft. in 15 miles of track, while the ends are only 5 miles apart on an air line. Then it crossed over a desert and up the valley to Arequipa. On the desert there are a great number of sand dunes, all moving in the same direction, many of them towards the line; when one of them gets to the track, it *will* cross; so the section men help it over. An expensive item in building from the sea, for over three-fourths of the line, was the water supply. At the start this was distilled from sea water; then more was needed, and it was hauled long distances. This cost about $5000 per mile. Now a pipe line supplies all on that section.

*One more has since been added to that number. This was on old work near the Verrugas bridge, and was rendered necessary by a storm which started a heavy slide.

†At Casapalca, 13,700 ft. above the sea, is the largest smelting works in Peru. This is served by two short spurs from the main line. The silver mines are all at high altitudes, Cerro de Pasco being over 14,000 ft. Those in the district near Casapalca are nearly 15,000, and some farther east are about 17,000.

The second road begins at Arequipa at an elevation of 7550 ft.; it crosses the first summit when out 118 miles, rising 7116 ft. more, and then passes on to Puno on Lake Titicaca, which is 100 miles farther and 2130 ft. lower. There are several developments on this road,—one, exceptionally fine, at Husamayo. It is about as long as the one on the Arequipa road.

The third road of this system branches off from the second at Juliaca, 29 miles from its terminus. It runs nearly due north, and reaches the summit of the range that separates this interior basin from the Amazon valley in 96 miles and at a height of 14,240 ft. above sea level. The descent to Sicuani is made in 30 miles, with a fall of 3140 ft.

A VIEW ON CAHUINTALA.

This town is on the Ucayali, one of the larger branches of the upper Amazon. Sixty miles farther on the line leaves this valley, and runs up a branch to Cuzco, 24 miles away and nearly 1500 ft. higher.

On the whole of this system there was, practically, no clearing to be done, and long tangents could be had. The location was easy, except on the developments. There were long pieces of light work on all three roads, and the average quantities would be considered but medium work. Of this but a small proportion was solid rock. All of these roads entered the mining regions. The Central took up coke and brought down silver and ore for shipment abroad; all had some business in hauling ores. A farther extension of the three northern roads will result in a large coal traffic.

FUTURE METHODS OF SEWAGE PURIFICATION.

By W. L. Hedenberg.

EXPERIENCE teaches us that at the present day apparently the best results in the way of purifying sewage are obtained by combining some of the simpler forms of chemical precipitation with the filtering of the effluent through land. This combination, however, is exceedingly costly, and therefore cannot be adopted by other than wealthy communities.

As by far the greater number of places in need of sewerage systems are towns or small cities, where only a moderate appropriation can be obtained, some cheaper or more inexpensive method has to be adopted. Recourse is then had to mechanical filtration and turning the effluent into some stream; filtering the sewage through prepared filter beds; or precipitating the sewage by one of the numerous chemical methods.

Mechanical filtration in no wise purifies the effluent, but simply extracts the insoluble matter, and should be recommended only when but a small appropriation can be obtained and where it is proposed to turn the effluent into a large body of moving water.

Filtering the effluent through soil necessitates a considerable outlay of money for the land and labor preparing it; in many cases it involves a pumping station with all the expenses thereof, and is often beyond the means of a small community.

Chemical methods are in most cases complicated and expensive, and the results obtained doubtful. Analysis certainly shows that a considerable amount of impurity may be removed by precipitation and the number of bacteria reduced, but a large amount remains, and, although the effluent may be odorless and almost colorless, if it is kept for a few hours the odor in most cases becomes unbearable.

Almost every conceivable combination of chemicals has been tried, either in this country or abroad, and nothing has as yet been discovered that, taking everything into consideration, can be called a success. Either too little chemical is used, with a view of keeping down expenses, as was the case at Worcester, Mass., and the effluent goes out impure, or a large amount of chemical is used at an enormous cost, and the effluent is turned into a stream so full of lime, alum, copperas, or perchlorid of iron that it is impossible for fish to live in the neighborhood.

In the United States land is much cheaper than in France, Ger-

many, and other European countries. But in years to come, as this country becomes more thickly populated, large areas suitable for the filtration of sewage near our cities will entail an enormous outlay of money. Bearing this and the mediocre results usually obtained by chemical methods in mind, it would seem about time that engineers were branching out into some new line of inquiry, with a view of discovering a method by which liquid wastes may be as thoroughly purified as by filtering through sand or earth. From all appearances the means are at hand ready to be experimented with, and a few of the more progressive engineers, especially abroad, have already directed their attention to it. The writer refers to electricity, which will undoubtedly be the purifying agent of the future.

Two well-known methods of manufacturing a disinfecting liquid by electricity have appeared during the last few years. One is known in France as the Hermite system; the other, in this country, was invented by Mr. Albert E. Woolf, and is known as the Woolf process.

These two systems are very similar, and differ only in detail and method of application.

Mr. Hermite, bearing in mind the old saying that "an ounce of prevention is worth a pound of cure," aimed at destroying the cause of disease at its birth, while the Woolf system undertakes to render sewage, garbage, or other matter that has already undergone decomposition sterile and harmless.

In both of these systems the disinfectant is a liquid obtained by passing a high current of electricity through sea or salt water. The Hermite process has been tried in a number of cities in France and in several towns in England. In the former country plants have been installed at Havre, Brest, Paris, Nice, Loriente, and Monte Carlo. The Hermite system usually consists of a closed iron vessel in which the electrodes are situated, a dynamo, the necessary engines and boilers, and a supply of sea water, with pumps and distributing mains.

The negative electrode is made up of discs of zinc, which, when in operation, revolve. The positive electrodes are fixed between each pair of discs, and consist of glass tubes covered with a coating of platinum. The iron tank has at the bottom a pipe with perforated holes, through which the sea water is admitted.

The action which then takes place, expressed in chemical symbols, is about as follows:

	Negative electrode.	Positive electrode.
H_2O	H_2	O
Na Cl	Na	Cl
$Mg Cl_2$	Mg	Cl_2

Thus the water is decomposed, hydrogen gas being liberated at the negative electrode and oxygen at the positive. The sodium chlorid suffers decomposition, the base sodium being set free at the negative electrode and chlorine at the positive. The magnesium chlorid is broken up, the base magnesium appearing at the negative electrode and chlorine at the positive. From the bases and free chlorine produced in this way hypochlorites are formed, which are undoubtedly the active disinfectants.

In this system the idea is to use the disinfecting liquid as ordinary water, both in the public sewers and also in the closets of private This would require considerable piping; so in most cases, as at Worthing, England, the sewers alone are flushed.

At Nice it is claimed that in time of heavy storm the disinfecting liquid is so diluted that it loses a great portion of its efficiency. This would appear to be a reasonable conclusion, notwithstanding Mr. Hermite's argument to the contrary, as the majority of sewerage systems throughout France are those known as the combined system, in which both the household wastes and storm waters are admitted.

Such a method of disinfecting would probably give much more satisfactory results in this country in small cities and towns where the separate system of sewers exists. Arrangements could be made at a comparatively small cost to distribute the disinfecting liquid to the flush tanks of a system allowing them to discharge automatically their contents directly into the sanitary sewers.

Experiments with the Hermite system were carried out on the most extensive scale at Brest, where the sewage of 11,000 people was treated. Dr. Pitau, in an official report dated February 21, 1894, says: "In a word, the experiments which I have made enable me to conclude that electrolyzed sea water is a perfect disinfectant and an excellent antiseptic, which very rapidly destroys all microbes, even the most tenacious of life, on the condition that these microbes are brought into contact with the electrolyzed sea water."

Mr. Draghi, a chemist on the committee to examine into the Hermite system at Nice, estimated from the experiments made that the cost of the system per year per inhabitant is 48 cents.

At Havre there were two separate plants consisting of two 35-h. p. engines with double electrolyzers. Five centrifugal pumps were constantly in use: three forced the disinfectant into an elevated storage reservoir, a fourth was used to convey a supply of sea water, while the fifth circulated the liquid through the electrolyzers. The experiments showed that 440 gallons of disinfecting liquid, containing about 35 grains of chlorid per gallon, could be produced in an hour at a cost of $13.30 a day.

If, as Mr. Hermite claims, the disinfectant may be diluted a great number of times and still retain its purifying qualities, by thoroughly mixing the liquid at the rate of 440 gallons per hour with the sewage of a community as it flows into settling tanks, excellent results should be obtained at a much less cost than would be incurred in supplying every house with the disinfectant. As can be readily seen, the principal objection to the Hermite system would be the necessity of connecting the sink, drain, and closet in every house of a city with a special supply of disinfectants, entailing a net-work of pipes similar to that of a water-supply system.

The Woolf process is similar to that of Mr. Hermite, in that the disinfecting liquid, which is known as electrozone, is obtained by passing a large current of electricity at a low voltage through sea or salt water. The water to be electrolyzed is pumped into a large vat or tank, in which is placed a platinum zinc couple. The platinum electrode consists of a copper core with a platinum coating .003 in. in thickness.

The chemical action which takes place, when the electrozone is brought into contact with sewage, is about the same as that in the Hermite system; the chlorids and bromids in the sea water are converted by the high electric current into hypochlorites and hypobromites, a portion of the chlorine replaces the hydrogen which is liberated from the organic matter, and the liberated hydrogen unites with chlorine and forms ozone, which tends to further purify the organic matter.

The first plant was installed during the summer of 1893 at Brewster, N. Y. This plant consisted of a 15-h. p. engine, a dynamo capable of generating a current of 700 amperes at a pressure of 5 volts, a vat of 1000 gallons' capacity containing the electrodes, with a supply tank designed to hold 3000 gallons. The electrozone was allowed to flow into the sewer, and was also sprayed into Tonetta brook, at a rate of 1 part hypochlorite to 100,000 of water.

A bacteriological examination made by the New York board of health showed the following striking results:

NUMBER OF BACTERIA
per cubic centimeter.

Before treatment.	After treatment.
32,600	8
22,000	42
2,353	12
4,134	0
7,000	0

Mr. Woolf stated to the writer that he considered the plant at Brewster sufficient to thoroughly disinfect the sewage of 30,000

people, if run to its full capacity. Such being the case, assuming a coal consumption of 6 lbs. per horse power per hour at $5.50 a ton, the cost of fuel per annum would amount to $2168.10. Three assistants, at a total cost of $2737 a year, with sundries at $300, would make the running expenses $5205.10, or a cost per inhabitant per year of 17 cents.

About a year ago the Woolf system was installed at Danbury, Conn., for the purification of the sewage. The plant consists of a 40 h. p. engine and a dynamo giving a current of 1000 amperes at about 5 volts. The disinfectant is generated in a vat situated near and above a tank through which the sewage is made to flow. The electrozone is allowed to run into the tank by gravity, the flow being regulated by a valve. The disinfectant and sewage are thoroughly mixed by an agitator in the tank, and, as the sewage rises, it overflows into a line of pipe which discharges into the river. The cost of running the plant is about $12.50 per day,—$7.50 for labor and $5.00 for salt, oil, and fuel. With a population of 16,552, the cost per inhabitant per year amounts to 27 cents.

The results obtained so far have been good according to analyses; complaints have been made, however, by persons along the river, owing to the fact that the heavy part of the sewage is allowed to find its way into the stream. This should very easily be remedied by adding a settling tank, or by the use of screens.

The problem at the present time, in inland sewage disposal, seems to be how to dispose profitably of the sludge after the liquid has been clarified and turned into some water course. At a few localities, such as East Orange, N. J., and Chautauqua, N. Y., the sludge is pressed into cakes by means of a filter press, and is then in a harmless and unobjectionable form. The cakes are easily handled and make an excellent fertilizer. But in most cases there is no market for them in the immediate vicinity, and in many districts where the soil is naturally fertile a premium has to be paid for the removal of the sludge. In some localities it is allowed to accumulate in large quantities near the disposal plant, and occasionally an effort is made to bury it at the expense of the community. In England, under similar circumstances, special furnaces were erected in some cases, and the sludge was disposed of by cremation. It was found that, after once starting the fire, the sludge, in cakes containing in the neighborhood of 20 per cent. of moisture, was self-consuming. The vapors and poisonous gases given off were passed through a furnace in order to render them harmless before allowing them to escape through the chimney to the open air. This method, as will be readily seen, necessitates an extra outlay of money, and is against the principles of economy, as the sludge theoreti-

cally ought to partly, if not entirely, pay for running the plant. The cakes, as they come from the sludge press, usually contain about 40 per cent. of moisture. By reducing this amount, and heating the cakes sufficiently to expel the greater portion of the poisonous vapors, the sludge might make good fuel, resembling to some extent peat, and could be used instead of coal for generating steam. If this could be accomplished, the great problem of how to dispose of the sludge would be solved in a way that would yield no little revenue.

An ingenious method for the profitable use of the sludge is that known as General Scott's sewage cement process. After the heavy matter has been precipitated by the addition of lime and clay to the crude sewage, and the effluent has been disposed of in some way, the sludge is burned by intense heat and then ground into cement. The burning of the deposited matter with the mixture of lime and clay renders the cement inodorous. An excellent quality of cement can be procured in this way, it is claimed. The method has been tried at Ealing and Birmingham in England; at the latter place, however, it was not remunerative, and was abandoned.

It will be found interesting to compare in a general way the methods of sewage purification usually adopted with the purification by electricity. In determining the cost per inhabitant per year, the interest on the first cost of the plant itself is omitted in every case, the aim being to compare the actual running expenses of the different plants per year per inhabitant. In the case of intermittent downward filtration through prepared filter beds or broad irrigation, the interest on the cost of the land and its preparation has been added to the cost of labor, fuel, etc., in determining the cost per year, as in this method the land is the means of purification just as chemicals are in the chemical precipitation method.

An excellent example of the purification of sewage by a combination of chemical precipitation with the filtering of the effluent through land is to be found at East Orange, N. J., a wealthy suburb of New York, with a population of 13,283. The sewage, on reaching the disposal plant, is thoroughly mixed with lime and sulphate of alumina. It is then made to pass slowly through settling tanks, where most of the solid matter is precipitated, and from which, after passing upward through coke, the partially clarified liquid flows to the filtration area. This area consists of about 14 acres of land, thoroughly under-drained and laid out in beds. As the soil was very retentive, artificial beds of coke and gravel were added. The cost of operation of this plant was given for 1890–1891 at $8700 per year. The total cost of the disposal plant, including land, underdraining, machinery, etc., was $95,847.80. The cost of land and preparing the disposal beds was $20,749.20.

Adding the interest on the last figure at 4 per cent. to the cost of operation, we find the total cost of running for one year to be $9529.97, or, with a population of 13,283, a cost per inhabitant per year of 71.7 cents.

An analysis of the effluent, made by Professor Leeds, of Stevens Institute, after the chemical treatment, as it leaves the coke filter, showed a large amount of unoxidized sewage. The effluent was turbid, with an unpleasant, musty smell.

Another analysis of the final effluent, made as it came from the underdrains and ran into the brook, showed an almost entire disappearance of the nitrogenous organic matter, the effluent being about as pure as the water usually found in country streams.

South Framingham, Mass., purifies its sewage by intermittent downward filtration combined with broad irrigation. This town in 1890 had a population of 9239. The sewage is pumped to the farm, which consists of about 62 acres, 12 of which are laid out into beds and thoroughly underdrained. The original cost for the whole system, including 5 miles of sewers and the disposal plant, was $145,000. The cost of maintenance during 1891 was $6500. The cost of land and preparing the beds was not given separately, but was probably not less than $30,000. Adding 4 per cent. interest on $30,000 to the cost of maintenance, we find the total yearly expenditure to be $7700. With a population of 9239, the cost per inhabitant per year would be 83.3 cents. The analysis of the effluent after treatment, made by the Massachusetts board of health, showed that most, if not all, of the free ammonia, albuminoid ammonia, and bacteria had been removed. Consequently the effluent was about as pure as ordinary potable water.

The well-equipped chemical precipitation plant at Chautauqua, N. Y., on the south shore of Lake Chautauqua, furnishes an excellent opportunity of studying the results obtained by this method and the cost of maintenance. The population of Chautauqua varies at different seasons of the year, as it is a summer resort. The average population, however, is about 4000. The plant was ready for use in July, 1893. The chemicals used are lime, alum, and copperas. The sludge is pressed into cakes by means of a filter press, so as to be more easily handled and disposed of. The cost of operating the plant, including chemicals, fuel, and labor, is given at $2299.50 a year, or, with a population of 4000, a cost per inhabitant per year of 57.4 cents.

The analysis of the sewage and effluent made by Professor Perkins of Union College showed that 80 per cent. of the solid and 76 per cent. of the albuminoid ammonia were removed by precipitation. The effluent of Chautauqua contains, however, about eighteen times more albuminoid ammonia than the effluent which comes from the coke fil-

ter at the East Orange works. In short, the sewage is only partially purified, but, as the effluent is turned into Lake Chautauqua, which is a large body of water, no harm arises from it.

The cost of the various methods per inhabitant per year are, therefore, as follows:

Hermite System, Nice	48
Woolf System, Danbury, Conn	27
Chemical and Land, East Orange, N. J	71.7
Land Filtration, S. Framingham, Mass	83.3
Chemical, Chautauqua, N. Y	57.4

The purification of sewage by electricity is in its infancy. It is safe to prophesy, however, that in years to come electricity will play an important part in sanitation. So far the methods of applying the disinfectant to the sewage are rather crude, and could be greatly improved upon. A step has been taken apparently in the right direction by an English chemist, named Webster, who, availing himself of the fact that most crude sewage contains a large number of chlorids, passed the sewage itself through the electrolyzers and disinfected it directly. If there was not enough chlorine in the sewage, some was added. Iron electrodes were used in this method, and consequently iron and chlorine were liberated by the current. The chlorine is the disinfectant, while the iron liberated unites with oxygen, forming a precipitate of oxid of iron, which carries down most of the suspended matter. As in most cases chlorine would have to be added to the sewage from an external source, and as chlorine is a rather expensive chemical, this process might become exceedingly costly. The same results probably would be obtained at much less expense by adding a saline solution to the crude sewage.

In any case, the results so far obtained by the different electrical methods justify careful study and research in this line by all progressive sanitarians.

UNDERFLOW AS RELATED TO IRRIGATION.

By H. V. Hinckley.

UNDERFLOW is the name which, locally at least, is most commonly applied to the sub-surface waters of the "Great Plains," whether under the beds of the streams, the valleys, or the surface of the plains generally. Prof. Hay says :* "It would be best to restrict the term underflow to the proved sub-water of alluvial valleys, and possibly to that of some of the basin regions of the Southwest. The common well-diggers' term, 'sheet-water,' may very appropriately be used for the bodies of water which are so abundant under the higher levels of the Great Plains." Mr. Gregory † calls the sheet-waters "underflow." For the purposes of this article, and for reasons which may be apparent hereinafter, the term underflow is assumed to apply to all recoverable sub-surface waters anywhere, provided they are above sea level and without gas, or artesian, pressure.

A much mooted question has been whether the underflow really flows, and if so at what speed. Residents, in sinking wells in the sands and gravels of the plains, report strong currents of underground water flowing usually in the direction of the general slope of the country, but at times more nearly toward the nearest valley or stream. Conservatives, however, tell them that the apparent current is simply that which is due to the pumping from the well, and that the water naturally comes in from the up-hill side. The statements of numerous well-owners to the effect that, when no pumping is being done, a straw floating in a well invariably goes to the down-hill side of the well are generally considered to be illusions of water-supply enthusiasts. One prominent authority (?) says there can be no flow of water in sands because the capillarity thereof must nullify any tendency to lateral motion. Another prominent authority, who admits that lowering the surface level of water in a well increases the flow into the well, still insists that the flow of water in the sands or gravels of any valley must be independent of the slope.

Mr. Follett § failed to find any flow in the silted surface sands of the Rio Grande bed near El Paso ; he also failed to find any flow in the sands and gravels of Cherry creek bed at Denver, having a slope of about 30 ft. per mile, although he noticed *incidentally* that a hole dug in the bed of the creek "would instantly fill with water." It is interesting to note that the city of Denver has drawn off from the bed of

* U. S. Senate Ex. Doc. 41, Fifty-second Cong., "Report on Irrigation, 1893," part iii., p. 35. † Ibid, part iv., p. 28. § Ibid, part ii., p. 35.

this creek by gravity from 2,000,000 to 9,000,000 gallons a day. In accounting for the disappearance of rain water, Mr. Follett computed the rate of movement in the sands of the Frenchman Valley, where it crosses the Colorado-Nebraska line, to be $\frac{1}{4}$ in. per minute. An article* by him had for its title: "Can the So-called Underflow of the Semi-Arid Region be Utilized for General Irrigation?" and among its conclusions the following: "The rate of movement in the sand is very slow. . . The amount which may be drawn from it without permanently lowering its level is small. . . The supply is not such as to warrant large expenditures in constructing plants intended to obtain water sufficient for irrigation. . . Even if momentarily successful, as a plant would be, drawing down the surface of a lake with no *outlet*, the supply will be exhausted; in other words, the water surface will be permanently lowered, and disaster to the irrigation plant will follow." In the government report† he says: "It must be remembered that the annual precipitation on this (Great Plains) region is small and the evaporation quite large; and, after taking into account what runs off in storm-water channels, the amount that finds its way into the earth below, where no loss can occur from evaporation, on the average must be very small."

It is certainly best to be on the conservative side of the question, but any logic, arguments, or scientific statements having a tendency to belittle the underflow have not been pleasantly received by dwellers in the Arkansas valley (for example), who insist that the underflow has a lively gait. There have been advanced by students of the subject three general ideas as to the source of the underflow; first, that it comes, far underground, partly or wholly, from the mountains; second, that it is forced up from the "bowels of the earth" by some mysterious agency of nature; third, that its only source of supply is the rainfall. It has become evident that the underflow is too much misunderstood,—its laws, if any, too (entirely) unknown.

The public importance of the underflow and the necessity for understanding it may be appreciated upon consideration of the following propositions: Uncle Sam's population doubles every 30 years. This means sixty or seventy million more people to be provided for by 1925. He may be "rich enough to give them all a farm," but his available farms are in the arid and semi-arid regions, where rainfall is inadequate for successful agriculture, and irrigation development is the only recourse. The certain increase of population, the urban unrest of to-day, and the contentedness and prosperity of irrigation producers in communities which are properly founded (for or by the people) point conclu-

* *Engineering News*, April 6, 1893. † U. S. Senate Ex. Doc. 41, part ii., p. 36.

sively to the coming empire in arid America. That water-supply must be the first course in the foundation of this empire finds an unfortunate illustration in the fact that a third of a million people have abandoned the lands which Uncle Sam had given or sold to them in western Kansas alone, because the rainfall was insufficient or improperly distributed to produce crops, and they had not been advised as to whether underground waters could be successfully and profitably raised, by pumps or otherwise, for irrigation. Irrigation is the only insurance that pays annually the full face of the policy. Of the arid area (one billion acres), Major J. W. Powell, late director of the United States Geological Survey, estimated that a hundred million acres may be eventually brought under irrigation when all the sources of water-supply (or, better, all the methods of conservation, for there is but one source of supply) shall be fully utilized. This area will support, directly and indirectly, under thorough cultivation, from three to four times the present population of the Union. Up to this time less than one-tenth of this area (stated by two authorities as 4,000,000 and 8,000,000 acres) has been so reclaimed (and cultivated); and, while many mistakes, large and small, have been made, and much capital has been lost by a lack of comprehension of the facts regarding water-supply, as well as through "scheme" promoters, still the average value per irrigated acre, according to the census of 1890, was something over $83.

On account of the continuous and disastrous failures of the dry farming lottery in the west, State, Inter-State, and national conventions have brought into consideration the possible methods of developing water-supplies for agriculture. Now, if by any manipulation of the water-supply, or by the adoption of any different policy or method of procuring or conserving water, the area irrigable can be increased 50 per cent., the result would be an additional irrigable area of 50,000,000 acres, which, at the average value in 1890, would be worth over $4,000,000,000. Again, if from a better understanding of the water-supply and the best methods of utilizing it millions of acres may be made more readily irrigable by the individual farmer, independent of any monopoly or bonded syndicate, a more ready development and a more satisfactory condition of community interests must result.

Major Powell is authority for the statement that in general the less the rainfall the less the percentage that runs off (stream measurements), and that, where the mean rainfall is 20 in. per annum, the mean run-off is 2 in. as measured in the surface flow of the streams. What, then, becomes of the other 18 in.? Can it be recovered, and, if so, how?

It seems evident that any man who thinks must be reasonably sure that, when the amount of water contained in a well or other hole in the ground is pumped out, one of two things must happen,—the well

must remain empty, or the underflow must flow; also that, when a river in a dry season increases in volume as it flows, some other agency than the evaporation from its surface must be the source of supply which causes such increase; also that flowing springs, known nearly everywhere as the most reliable furnishers of water, unless they be supplied by flow through sands or gravel, must be continually sloping holes with no upper ends,—an absurdity indeed.

Having been employed as expert in a law suit involving the question of possible permanent supply by wells in a certain valley; having also been employed to design a gravity system to utilize the entire underflow of one of the large plains rivers; and having devoted 2 years entirely to the study of water-supply for irrigation development,—the writer has made several hundred tests of well-infiltration and flow of water in sands and gravels (coarse and fine, and various combinations of them), with slopes ranging from 3 ft. to 350 ft. per mile. To give the details of these tests with resultant curve diagrams, formulæ, and explanations, would require a long paper; moreover, the writer desires to complete at least one thousand tests before publishing the results. It is not the purpose of this article to anticipate and answer all the questions that might be asked regarding underground water-supplies, or to suggest the writer's ability to do so, but simply to present the following general conclusions resulting from his study.

The only source of the underflow is the rainfall, though geological conditions may be such that rainfall in one drainage basin furnishes underflow in another, and helps to supply another stream. The bed of a mountain stream, like the Arkansas or the Rio Grande, may have a continuous underflow from mountains to ocean; but the water that starts in the underflow at the mountains seldom, if ever, traverses the entire distance to the ocean, or any considerable part of it, generally reaching the surface of the stream by gravity, and then being evaporated. Underflow of the same level as the stream water, or nearly so, is limited to the width of the valley proper generally, but not always,—depending upon geological features. In general, the surface of the underflow tends to follow the ground surface, being higher, but at greater depths, under the divides and sloping toward the rivers. If the water-bearing material in the valley bottom is not much coarser than that back from the river, the slope of the underflow may extend to the river; slopes in sand, of 30 ft. per mile and possibly much more, exist to the river banks, while in valleys underlaid with coarse gravels the transverse sections of the valley proper usually show a level, or nearly level, water surface. All underground waters in sands and gravels, unless caged in some geological seam or pocket, are in constant motion under the influence of gravity, generally from the divides

to the valleys and down the valleys, but, in rare cases, where the divides are sand to depths below the river levels, the water movement is in a direction away from the nearest river; in short, the water seeks lower levels by the most practicable route. The amount of water in saturated sands and gravels ranges from less than 20 to more than 40 per cent., the theoretical maximum per cent. held between spherical grains being 48. The percentage volume of water depends mostly upon the uniformity of coarseness of material. Fine sand, if free from silt, contains the same percentage of water as coarse sand, or even coarse gravel, the general shape of the grains being the same. Very fine and silted sands and clays hold high percentages of water, but do not readily give it up or pass it along. A coarse gravel holding 40 per cent. of water may be so mixed with finer gravel and sands as to contain only 20 per cent. of water. The percentages of water that may be drawn off by gravity or by pumping, from the sands or gravel, are not proportional to the percentages held in them. The coarser the material, the greater the percentage drainable, because fewer grains give less area of capillary surface; but a portion is invariably held back from the flow by capillarity. The greater the uniformity of sizes of grains or pebbles, the greater the percentage drainable, and, the coarser and more uniform the material, the greater the drainage speed. In a given material the speeds of flow are nearly in proportion to the slopes in feet per mile. The flow in coarse gravel with a slope of 50 ft. per mile (for example) is several hundred times the flow in a medium fine sand with a slope of 5 ft. per mile.

Any statement to the effect that the underflow has no flow, or that its flow in general is at about a certain rate, without stating the conditions governing that rate, is worse than a waste of time, for its flow varies under well-defined laws and between the limits of quiescence and a lively current.

Some streams, dry most of the year in the upper part of their course, become perennial further down from the constant underflow from the highlands; one stream, for example, in western Kansas, flowing in sand and falling 13 ft. per mile, was receiving last winter from the underflow, after a very dry *year*, 26 cu. ft. per second in a distance of 6 miles. Sands and soils above the saturated water level are wet by capillarity, and, when a well-borer brings up wet sand, he has not necessarily reached the water surface by several feet. The height of the capillary wetting depends upon the fineness and uniformity of the sand, but has no effect upon the flow of the water in the *saturated* sands and gravels below.

The supply that will percolate into a given well depends upon its depth, its diameter, and the coarseness of material delivering the

water to the bottom of the well. In an unstratified and uniform material constant pumping from a well produces an inverted conical water surface around the well, which surface, after stopping the pumps, returns to practically the original water level in from 1 hour to 24 hours, —not instantly, as many reports indicate.

The supply that a given well or other gathering chamber, in a given valley, will furnish permanently depends, first, upon the rate of infiltration; second, upon the cross section of valley, the slope thereof, the character of the sands, and the consequent speed of flow; third, upon the extent and character of the drainage area.

Determinable currents do exist through material at bottom of wells, and, when well walls are laid loosely without cement, may, in favorable material, exist at or near the surface of the water. In general, the lower strata currents are many times stronger than the upper. The conclusions and findings of Mr. Follett, whom I may seem to have been attempting to "call down," as well as the conclusions and findings of the other government experts, are, in general, corroborated by my experiments. The trouble between their conclusions and the people is that the people, and in general the engineers, are not sufficiently posted on the laws of underground waterflow to talk advisedly thereon. While residents say that the underflow is inexhaustible, the expert says it is not; and upon these grounds they stand, fighting a French duel, with a common cause at heart and both of them right. The underflow is exhaustible or not exhaustible, according to the means employed and the intelligence exercised in connection therewith.

The underflow of some streams or valleys is but a fraction of 1 per cent. of the surface flood flow. The average annual underflow passing a given point is seldom, if ever (owing to evaporation), equal to the average annual surface flow. The dry-weather underflow often exceeds the rainy-season underflow, and often exceeds the dry-weather surface flow very materially, for in the west the latter often becomes nothing. The underflow of any stream or valley is far more reliable and constant than the surface flow, and the writer's study has made him an optimist regarding the underflow for irrigation.

Gravity plants can be put in,—good for 80 or 100 years,—with no annual expense for maintenance or operation, that will deliver at the surface a steady flow the year round at a first cost of from $5 to $25 for 1 acre ft. every year. Thousands of (generally small) pumping plants can be put in at from $5 to $10 an acre, with an additional annual expense for repairs, fuel, etc. The former is the corporate or community plant, the latter the individual plant. Either plan must be carried out with a thorough understanding of all the conditions. Too many canals are being built where the reliable supply is not a canal

supply. Too many pumps are being put in that are not best adapted to the work to which they are assigned. Gravity systems properly designed furnish from the immense reservoirs provided by nature the most reliable water-supply obtainable, and in this manner may be utilized at least a good share of the large and immediate run-off that is lost to view before reaching the stream gages of the government.

Throughout arid America, in which it is proposed that two hundred million people shall be prosperous on irrigated farms, the wealth of this coming empire is in the water, while sun and wind and the resulting evaporation are the robbers who would stimulate maximum plant growth, and at the same time take from the face of the country the plant blood necessary for such growth. The great problem of the west then is to conserve water-supplies against evaporation,—which averages from 4 to 10 ft. per annum, depending upon locality, and which reaches a frequent maximum of at least 1 in. a day and a rare maximum, in hot winds, of at least 1 ft. a day. These figures represent the amount of evaporation where the water is in sight. If the robber fails to find so much, he takes only what he finds. The failure to find any flow over the rock-bed of the Rio Grande at El Paso, Texas, is certainly no basis for the opinion that there is no underflow at Albuquerque, New Mexico.

The mean surface flow of the Rio Grande at Del Norte, Colorado, is 0.80 second feet per square mile drained. At Embudo, New Mexico, it is 0.20, and at El Paso, Texas, 0.06; or, in another light, the annual flow above ground at Del Norte (drainage area, 1,000,000 acres), at Embudo (5,000,000 acres), and at El Paso (20,000,000 acres) is practically the same, being generally from a half million to a million acre feet, equivalent at the latter place to a run-off of only (say) ½ in. annual rainfall. Excepting the mountain floods of April, May, and June, practically no water reaches El Paso, the light rains being evaporated from the face of the country, and the heavier local rains, along with the great share of the snow waters, going into the underflow to be gradually evaporated.

There are at least three possible methods of conserving waters in such cases. An international dam may be built at El Paso costing $1,000,000,* and empounding early each summer 500,000 acre ft., having an average depth of 23 ft., thus utilizing, possibly, 5 per cent. of the rainfall of the Rio Grande basin; smaller dams may be built in the mountains to supply local canals; and thirdly (upon which I wish to lay stress) nature may continue to store in the sands and gravels of the valleys as she has done for centuries, and the individual farmer may pump from under his valley farm, and the corporation may

* Tenth Annual Report U. S. Geol. Survey, p. 145.

develop underflow gravity supplies, nature replenishing the supply, in either case, once a year.

At least two thousand individual pumps, operated by wind, steam, and gasoline power, in western Kansas alone, are successfully and profitably watering farms (many of which had been abandoned by previous owners) from the underflow found at depths of from 10 to 150 ft. below the surface. The pump system of water-supply must become more popular as its good points become more appreciated. There are canals in the Arkansas and other valleys that are dry during the critical part of the summer season, because the streams are then dry. Intelligent gravity development will give them a summer flow or an all-the-year flow, as desired, within reasonable limits of expense, but such plants must be designed with a thorough understanding of the underlying material and the water-supply and its movements. Some of the gravity developments, as well as pumps, now in use, while considered successful, are faulty in design, and therefore more costly than they should be. To make a long story short, nature has provided immense storage reservoirs to which, at least on the great plains, no artificial storage can approach either as to capacity or freedom from evaporation. The beds of the streams are the safety-valves through which the surplus escapes to be evaporated or to flow to the sea. The more these features become understood, and the more individual pumps are put in to keep the water-level of the valleys down below the level of the river beds and away from evaporative influences, the greater will be the available water-supply. In other words, nature will help them who help themselves upon her plans.

A thousand city water-supply pumps and many thousand pumps for irrigation and other purposes, and a number of gravity conduits, are realizing, from the underflow, steady, reliable supplies of from 1,000,000 to 30,000,000 gallons per day, and developments along this line, in the writer's opinion, have scarcely begun.

RACIAL TRAITS IN MACHINE DESIGNING.

By Albert Williams, Jr.

IT is noteworthy that, notwithstanding the present closeness of intercourse between engineers the world over, through published accounts of machines and structures, in books, technical journals, and the proceedings of engineering societies, and by travel and personal inspection, there should still exist such wide variations in method in different countries. This is the more remarkable in view of the consensus of opinion as to underlying principles in almost all cases, and the fact that there are in many instances well-recognized standards.

Methods of course vary considerably in the same neighborhood; but it is a curious study to trace the manner in which racial peculiarities and environment show themselves in machine designing, in spite of the growing admixture of nationalities by the transference of engineers and artisans from one country to another, the availability of similar materials, and competition in the same markets. An examination of this kind is not merely a pastime professionally, but may have some practical utility, if it enables us to take broader views, to lay aside local prejudices, and to copy good features and avoid repeating bad ones, in looking over the whole range of construction as practised in different countries.

There are two main considerations in planning any machine, structure, or tool,—utility and economy. Under the former head the designer would place first effectiveness in operation; then the special or general applicability of the thing to be made, its durability, and its facility of construction. Under the second head he would have to consider the first cost, the running expense, the maintenance, and repairs. Then there is one more point, not always or perhaps even generally considered,—namely, the appearance of the machine, tool, or structure. This is by no means unimportant, for, besides its purely esthetic bearing, it certainly influences the adoption and sale. So long as the securing of a pleasing appearance does not antagonize any of the more important essentials, why should not the visual effect be taken into account? Here is ample scope for individuality. What is good taste? What effect have convention, habit, change of fashion, resemblance to popular models of other kinds? As to these questions no two persons precisely agree, but, when larger groups, such as whole nations or races, are considered, some broad differentiations can be traced.

It is safe to say that one who has given any attention to the sub-

ject, on looking at a new machine, implement, or tool, can make a tolerable guess as to its source without examining the trade mark or stamp of the maker's name and place of manufacture. Each bears upon it a certain individuality (unless it happens to be a mere copy, and even then a closer inspection might detect small changes), just as each human face has its own stamp. Could anything be more thoroughly British than the English "goods engine"? Where it is hard to particularize exactly, it is still possible to localize it within certain broad limits. After looking over the examples in any one mechanical department of a great international exhibition, a general idea of the field is obtained, so that, if the machines or tools of several groups were presented intermingled, the observer would be enabled to place them approximately, without referring to labels and stamps. Opportunities for simultaneous comparison on a wide scale, as offered by such exhibitions, are not given to all, or at all seasons, though becoming more frequent. But, without them, all have access to published descriptions and working drawings and pictures, and those who use their eyes—who see as well as look—may find much that is instructive presented all the time and without going out of their way to seek it. The everyday observer acquires the faculty of identifying, in more or less degree, until it becomes unconscious and instinctive, in somewhat the same manner that one roughly rates dimensions, weights, and proportions at a glance, without conscious calculation. The custom-house inspectors and patent-office examiners could supply some interesting testimony on this score.

Perhaps it would not be altogether profitless to inquire, given a certain engineering problem, how would a French, a German, an English engineer go about it? How would the habit of thought, the training, the experience, the natural bent, of each influence him in choosing his mode of solution, if there is more than one, and how would each work out the details? Surely it would not be useless to accustom oneself to look at things through the eyes of others, to place oneself at their mental standpoints, to avail oneself of the multifold experience gained under varying conditions, and still more to habituate oneself to laying aside, so far as possible, the personal prejudices depending on temperament. As an actual fact, this is what the engineering world is gradually approaching. Narrowness of ideas is giving way to a study of wide ranges of method and a willingness to adopt foreign systems, if they are better,—not as a servile imitation, but intelligently and consistently with modified conditions. But the tendency has by no means gone so far as to wipe out or much obscure these racial peculiarities of construction.

According to accepted notions of racial characters, the English

and Scotch are proverbially conservative, methodical, painstaking, and careful to secure durability by using sound material and often an unnecessary surplus of it, making safety a high factor. Their predilection for rigidity, leading to heavy frames and bed plates, sometimes goes to cumbrous extremes. They have not got over a partiality for hand work where special excellence is desired. Their machines are, as a rule, very reliable. Little attention is given to appearance and finish, and the machines have an extremely businesslike look, to the American eye overponderous and somewhat clumsy, the idea of construction suited to a great forging hammer or shears being repeated in smaller, fast-running machinery where it seems out of place. Like their machines, their bridgework and other engineering structures are very substantial. A characteristic instance is the choice of the cantilever where a lighter suspension bridge with stiffening truss would suffice. They have not gone very far in adopting interchangeability of parts and close template and gage adjustments, so that many of their machines are turned out as individuals which could be built in multiplicate, with corresponding loss of time under the prevailing system. In the export trade—always excepting the "Brummagem" goods—they have striven for a reputation for reliability, so that for some articles, such as hand tools and cutlery, a position was gained which is not undisputed by rivals at the present.

The French are quick, sensitive, innately artistic in all their perceptions, particular as to details and finish, and somewhat given to an inordinate desire for originality of effect leading sometimes to *bizarre* designs; their products, however "showy," are never absolutely unsightly. Attention is given to the appearance of tools and implements intended for the simplest and most homely purposes. Hand work is preferred to machine work, partly because it is cheap enough to compete with the machine tool, and partly because of the abundant supply of intelligent, skilled artisans in the lower grades.

The German designer, always well grounded in mathematics, calculates stresses and proportions minutely, but in the outcome does not shave so closely as the Yankee. He never allows himself to be hurried, and, in everything made for the home market, is conscientious. In the proportioning of parts with an eye for effect, he produces curved lines and rounded masses, reminding one of the drawing of the old Flemish and German artists, and which somehow fail to convey the idea of precision given by sharp, angular contours.

The Belgians have latterly become great fabricators of heavy metal work, and, as their low prices make them dangerous competitors, their rivals affect to impugn the excellence of material and workmanship. In certain lines of hand-made implements and firearms of the cheaper

grades they have long been prominent. The appearance of their machines, architectural ironwork, etc., resembles German rather than French models.

The Swiss have developed astonishing manual dexterity and the versatility required in making all, or nearly all, the parts of such a machine as a clock or a watch by one person; but recently, driven by competition to adopt machine work in factories, instead of isolated hand work, division of labor, interchangeability, etc., their system has been changing—to the detriment of individual skill, but to the benefit of the mechanical industries as a whole. As the kinds of machines and tools made at home are limited, they have acquired a marked individuality, difficult to describe, somewhat resembling French types. The wood carvings and hand-made woodenware for the export trade always seem to have a freshness of design, no matter how often repeated; but their cheaper watch movements, resembling the American ones of the same grade, are rather deficient in precision.

The Austrians, and the South Germans generally, turn out work resembling that of the North Germans, but showing less progress. The exports (to semi-civilized lands especially) are characterized by cheapness.

The Italian and Spanish designers have a tendency to retain medieval and renaissance traditions, both as to form and decoration, not only in such manufactures as weapons, but even, incongruously sometimes, in articles of strictly modern invention. Spain and Portugal are very backward in mechanical contrivances, depending upon foreign supplies. Italy, on account of her great military and naval equipment, has been forced to make progress in the line of heavy machinery, but even here she is not altogether independent.

Passing by other nationalities, which either use practically no machinery, or (like Norway and Sweden, Holland, Denmark, and Russia) do not offer striking examples, or (like the British colonies and India) follow English practice, slightly modified, or (like Spanish America) are dependent on Europe and the United States, we come to China and Japan. Neither country until lately made any machinery, though both exported some mechanical goods,—the Japanese cutlery and swords being of notable merit. Military requirements in both countries led to the establishment of great arsenals for the making of war material, and these were built and operated under English and German supervision, so that methods were mere copies. Japan, however, is becoming independent of foreign engineers, and will soon establish an individuality of its own, and one of no low order.

On first thought one would expect the work of the American designer to closely resemble that of his English kinsman, or to be of a

composite type, resulting from the race admixture. Yet it is neither the one or the other, but of marked individuality. We have not discovered the much talked-of "American style" of architecture, unless the tall steel-frame office building with its veneering marks an epoch in "style" as well as construction; but a new line of mechanical progress has been struck out in the United States. The causes are not far to seek and are well known. The requirements of a new and rapidly developing country naturally evolved the men and the means. The earlier demands for inland transportation brought out new types of locomotives and engines for river and lake steamers, while special attention was given to designing agricultural implements and mining machinery, in all of which entirely new methods were introduced. In the intermediate stage our specialties were light machinery, sewing machines, firearms, timepieces, "Yankee notions," etc.; but at present there is no limit to the variety, and the greatest advances have been made in the heaviest machinery, marine engines, pumping engines, mill engines, electrical plant, etc., until practically nothing in the mechanical line is omitted that is made elsewhere.

The American regards time and money as of the first importance. Labor is dearer than abroad, and, while there is a large stock of inventive genius, there has been relatively a dearth of skilled operatives of the lower ranks,—plenty of good foremen and men competent to manage complicated machinery, but few who (at the wages) could take the place of the machines. Hence we find a preponderance of labor-saving devices, machinery supplanting handwork in unexpected directions, for making and even assembling interchangeable parts, for handling materials and products,—a strict division of labor (of which the watch-making and shoemaking industries are good examples) with the final result that American artisans turn out more work per capita than average workmen elsewhere, so that the employer can afford higher wages, whether for day or piece work, and can generally select his operatives.

American peculiarities are strongly marked. The best ones are directness of design, by which is meant the shortest cut to reach a given end, the designer having in mind the thing to be done quite as much as the machine which is to do it; lightness and a close proportioning of parts; in machine work a near approximation to pattern; rapidity of construction and rapidity of action in the finished machine; the substitution of special steels and new alloys, hollow construction, etc., for older materials and construction; and a generally neat appearance of work, with burrs, lips, and roughness of casting removed. The American designer is not an artist, like the Frenchman,

but is more attentive to appearances than the Briton. He is gradually curing himself of the tendency to tawdry ornament, needless accessories of fancy castings, stenciled paints, japanning out of place, bright work for mere effect, etc. We are not an esthetic people, whatever we may pretend to others and to ourselves; other people take pains to inform us of the fact, so there must be something in it. The worst fault the American designer is accused of by the English competitor is a skimping of material down to the lowest notch. This is not, as a rule, deserved; yet there have been enough instances to give occasion to the charge. The accusation of using inferior material is not sustained; but certainly an American machine is seldom too expensive for its purpose, the idea being to hit the requirement safely and then not to overshoot it. On the contrary, the first cost of the machine may seem extravagant, but is justified if that will make it more rapid in operation or diminish the need of attendance. Probably, on the whole, American machinery is less lasting than English. If it serves its purpose, and meets the profit and loss question, that is enough.

Single machines and tools having a multiplicity of functions are a hobby with the American designer and inventor. The Yankee combination jack-knife and tool chest is a famous example, on the small scale. If you look over the patent gazette you will find many such things as combined reapers and binders, perfecting printing presses, universal milling tools, wood and metal lathes, channeling and drilling machines, etc.,—perhaps even combined knitting machines and baby jumpers, or pile-drivers and spice mills.

Another striking feature is the variety of single machines designed to perform a large number of similar acts at the same time, such as the multiple boring and sawing tools. This gives rise to a complexity of parts, but avoids the duplicating of main frames, beds and driving attachments, and single adjustments. In most cases it will be found to require higher skill to make, adjust, and repair American machines, with less need of supervision when once in working order; that is, some of the brain power put into their construction is saved at the other end in operation. This is not always so, delicately adjusted machines often requiring highly-trained supervision and feeding to give the intended results.

The triumph of the American inventive faculty is in those machines called "automatic," some of which are as nearly so as can well be imagined,—steam engine cut-offs, governors, and regulators, self-feeders and self-dischargers of many kinds, automatic belt elevators, conveyors, double inclined planes, aerial ropeways, and so on.

Much has been said as to the daring of the American inventor and

designer, and with considerable truth. Sometimes he carries it too far, with disastrous results to himself and to his backers; but such failures are not without their compensations to the world at large. If all were timid, or merely conservative, there would be little progress. Originality, it must be observed, is not the exclusive property of American designers by any means. On the contrary, the greatest discoveries in physics and mechanics on which modern machine construction is based have been, for the most part, due to Europeans, as would naturally be expected, in view of the greater amount of experimental research by foreign scientists. But in the first steps toward the application of great discoveries, in the constructive details which render them practically available, Americans have taken a leading position. So also in the early inception of many groups of machines, the first actually operative examples have been brought out in the United States. The original idea of the feasibility of doing a certain thing may have been had by many, and in the crude state may have been useless, until the man appeared who could produce a machine that would "work." Very few of the so-called inventions of the highest class were really invented by one person; most of them were the outcome of many minds. But it is unfair to detract from the merit of the mechanical genius who first brought them into use, by saying, as may be perfectly true, that the idea was an old one. It is the working out of mechanical details, the combining of well-known principles with the proper mechanism, in which merit consists; and this often means striking novelty in the adaptation of parts and motions.

In considering the influence of race characteristics upon the mind of the designer, the doctrine of evolution by natural causes and reactions supplies much light. The character of the country, its size, topography, climate, resources, density of population, and many other things go to form the mental habits of the people. An insular position, inadequate food supplies, large population dependent on manufactures, great coal deposits, and innate energy could not fail to turn the attention of the early English and Scotch engineers to the development of the steam engine, marine engineering and naval architecture, textile machinery, etc., and the necessities of the case have made their works, as already stated, eminently businesslike, with little attention to matters of taste and the British practice of to-day upon the same things. On the continent of Europe the mere question of latitude and consequent climate has stamped certain characters upon the several nationalities, which not only are reflected upon their arts and in their habits of life and modes of thought, but may be found repeated even in the machines, and implements which they severally make and use.

REVIEW OF THE INDUSTRIAL PRESS

WITH AN INDEX TO THE LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOURNALS OF THE UNITED STATES, GREAT BRITAIN AND THE BRITISH COLONIES.

INTRODUCTORY.

THE aim in this Review and Index is, (1) to give concisely written expert reviews of those articles of the month which are deemed of most importance; (2) to supply a carefully classified Index to *all* the leading articles published currently in the scientific and industrial press of the United States and Great Britain; and (3) to afford, through our Clipping Bureau, a means whereby all or any portion of this literature may be easily procured.

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ARCHITECTURE & BUILDING

The Late Richard Morris Hunt.

NOT only the architectural papers, but also other technical papers and the daily press, have joined in paying respect to the memory of one of the most successful American architects within the memory of the present generation. When a man like the late Richard Morris Hunt dies, a man whose influence beneficially pervaded the entire profession to which he belonged,—a profession honored by his membership—it is fitting that his virtues and talents should be recorded that those who follow may profit by so conspicuously bright an example.

The best account of the life and labors of Richard Morris Hunt which we have yet seen is a five-column article written by Mr. P. B. Wight in the *Inland Architect and News Record* for August. Of this excellent biographical sketch we shall endeavor to make an abstract which, though brief, may give our readers some idea of the career of this typical American.

Mr. Hunt was born at Brattleboro, Vermont, October 31, 1828. His father, Jonathan Hunt, was descended from a long line of New England ancestors, and from 1827 to 1832 was a member of congress. His mother was Jane Maria Leavitt. His older brother, William Morris Hunt, who died in 1879, was one of the most brilliant artists America has produced,—a painter imaginative in the highest degree, as well as a sculptor. His father died while he was still a youth, and his mother, who was a woman of high intellectual attainments, undertook the education of the children, which became the aim and study of her life, and for which fortunately she possessed the means. She moved to New Haven for this purpose. Here the boy Richard Morris attended a school of high character, and afterward he graduated from the Boston Latin school. In 1843 his family removed to Geneva, Switzerland. Mr. Hunt studied drawing and architecture about 5 years in the studio of Samuel Darier. After the organization of the American Institute of Architects, Mr. Darier was nominated by his old pupil for honorary membership, and was elected. In 1848 Mr. Hunt went to Paris and commenced a course of architecture at the École des Beaux Arts, and also became an *élève* in the *atelier* of Hector Martin Lefuel. During his residence in Paris he travelled much in Europe, Asia Minor, and Africa. In 1854, through the influence of Lefuel, he was assigned by the government to the supervision of the Pavilion de la Bibliothèque. In this work he not only carried out the designs of Lefuel, but is credited with having personally worked out many of the details. He also had at this time many great French architects of the period as associates.

In 1855 he returned to America, and here began a phenomenally successful career. At first he established an *atelier* and took pupils. Almost the first practical work he did involved him in the suit—now historical—of Hunt vs. Parmly.

Dr. Parmly, a wealthy and distinguished dentist of New York, erected two expensive houses on Thirty-seventh street, which were unmistakably built from designs by Hunt. No one else could have designed them, and certainly no one who had graduated only from a carpenter's shop. But Dr. Parmly, sustained by his "practical" builder and superintendent, insisted that he had never employed Hunt, and did not erect the buildings from his plans. Hunt sued, and astonished the court by the great pile of working drawings produced, all of which had been used on the building. But the jury rendered its verdict under Dogberry's "Crowner's quest law," and the case was lost. But it was of immense benefit to the profession in New York. It put all architects on their guard in making engagements with their clients, and helped to establish a uniform system of charges by percentage.

Best of all for Mr. Hunt, it brought him to the notice of the most intelligent class of wealthy New Yorkers, and thenceforth his success was assured.

We cannot follow the story through all the steps which led to renown, but will content ourselves by such indications of its extent and completeness as are indicated in the following paragraph:

"The following is believed to be a correct list of the titles and honors accorded to Mr. Hunt during his extensive career: president of the New York Chapter of the American Institute of Architects, 1868 to 1887; president of the American Institute of Architects, 1887 to 1891; president of the Board of Architects, World's Columbian Exposition, 1891; doctor of laws, Harvard University, 1892; president of the Municipal Art Society, New York, 1893; honorary member of the Architects' and Engineers' Society, of Vienna; member of the Society of St. Luke, Rome, Italy (said to be the oldest society of architects in the world); honorary corresponding member of the Royal Institute of British Architects; recipient of the royal gold medal of the Royal Institute of British Architects, June 19, 1893; member of the Central Society of French Architects; Chevalier of the Legion of Honor, 1882; corresponding member of the Academy of Fine Arts of France, in which, the number being limited, he took the seat of M. Matejco, a Pole. He regarded this as the highest distinction that had been conferred upon him. But the reception of the royal gold medal was a compliment as well to American architecture, of which he was a worthy representative. The highest honors in this country were the presidency of the American Institute of Architects, and the degree of LL. D. from Harvard University. A partial list of his works follows:

"The Parmly house, Thirty-seventh street, New York; dwellings on Park avenue, near Thirty-fifth street, New York; the Tenth Street Studio Building, the Lenox Library, the first buildings of the Presbyterian Hospital, the Coal and Iron Exchange, New York *Tribune* Building, Hotel Victoria, residences of C. O. D. Iselin and Henry Marquand, and the Marquand office-building on lower Broadway, all in New York; residences for Marshall Field and William Borden, Chicago; residence for William K. Vanderbilt, New York; the Yorktown Monument; pedestal for the statue of Liberty, New York Harbor; Soldiers' and Sailors' Monument, Portland, Maine; Vanderbilt Mausoleum, New Dorp, Staten Island; Theological Library and Marquand Chapel, Princeton, N. J.; Divinity School, Yale College; Gymnasium and Recitation Building for the United States Military Academy, West Point; Naval Observatory, Washington; Scroll and Key Club House, New Haven; Martin Brimmer's houses, Boston; George Vanderbilt's residence, "Biltmore," at Asheville, North Carolina; and at Newport his own cottage and those of the late Charlotte Cushman and the late Richard Baker, the 'Marble Palace' now owned by Mrs. Alva Vanderbilt, the residence of Ogden Goelet, and 'The Breakers,' his latest work for Cornelius Vanderbilt. Lastly may be mentioned the Administration Building at the World's Columbian Exposition."

This last was his most original work, and Mr. Wight calls it "the grandest monumental design ever made by an American." The author closes his article with the following feeling and well-deserved tribute to Mr. Hunt's character and professional skill and personal influence.

"As a man he had all the elements of greatness. His was the master mind, when brought in contact with others. He was serious or jovial, as occasion required. Like Yorick, 'he was wont to set the table in a roar.' He always had a ready story 'to point a moral or adorn a tale.' His language was quaint and original, but always forcible. He was totally unaffected, and was at home with 'all manner of men.' He was always ready to help the weak, and no enemy had any terrors for him. His whole life, teaching, and example had more influence than that of any other half dozen men in establishing a high standard of professional honor, and gave a dignity to the profession of architecture in America of which it was sadly deficient 50 years ago."

Foundations of the Cathedral of St. John the Divine.

THE building of this cathedral is probably the most important architectural work now in progress in the United States. When it is completed, there will be few larger, and, let us hope, handsomer and more costly ecclesiastical buildings in the world. *The Engineering Record* (Aug. 10), in describing the foundation work and some unexpected difficulties encountered in its execution, says the "finished building will be about 520×290 ft. in extreme dimension (about as large as St. Paul's in London), and will have a grand tower 445 ft. high. At present the construction is begun only upon a small part of the edifice, —*viz.*, upon the tower and its adjacent choir, for which the foundations are now well advanced.

"As the rock outcropped in places at the site, it was believed that solid and most satisfactory foundations would be very easily secured, but, when excavation and leveling was begun, it developed a singular and troublesome condition of affairs, which has necessitated much delay and expense. The stone—the familiar gneiss of the locality—was disposed in very irregular masses, the formation of which was almost like waves, the surfaces of the outcropping ledges sloping down in places at a sharp angle and intersecting at the vortex of troughs 20 to 45 ft. below the surface. At other places the surface of the solid rock was not so deep, but was very irregular, and much of the upper part of the stone was found loose and disintegrated or filled with pockets of earth and clay, so that considerable excavation was necessary to secure an enduring and reliable platform on which to impose the heavy and extensive loads of the enduring structure."

Pits for piers were therefore excavated and filled with concrete to an average depth of 15 ft. The most scrupulous care was taken to thoroughly clean the rock faces of pit walls, in order that the cementing of the concrete to the natural rock should be perfect. "The foundations will contain about 5000 cu. yds. of dimensioned granite masonry. Sooysmith mixing machines are used in making the concrete." Each mixer is set with the top hopper about level with a working platform that closely surrounds it at the surface of the surrounding ground, and upon which materials are delivered by wheelbarrow and derrick and placed in bins. Men with shovels keep it continuously fed into chutes that carry it down to a platform about 6 ft. below, upon which rest the lower ends of three inclined chain and bucket conveyor elevators that are driven at the same speed—about 2 ft. per second —by a small vertical engine on the same platform. This engine also drives the mixer. All are driven by belts which will slip and allow the machinery to stop when obstructed rather than break as a gear would. One elevator is encased throughout in a tight wooden case, the lower part of which is filled with loose cement, which it brings up and empties into the upper part of the mixer hopper. The next elevator is on the opposite side of the hopper, a couple of feet nearer the discharge end, and delivers sand from a heap at the foot of the chute below, where two men are constantly in attendance to see that each bucket is level full. The third elevator is 2 ft. further away on the same side as the cement elevator, is similarly served by two men, and delivers gravel. The mixer is about 12 ft. long over all, and inclined about 1 in 12 down towards the discharge end. Its shaft makes about 20 revolutions per minute, and is fitted with about sixty inclined beveled radial cast-iron arms that mix the materials very thoroughly, even before they are wet by a man with a hose nozzle just opposite the gravel elevator, and considerably more afterwards. The elevator buckets each hold about 1 cu. ft., and discharge their contents over to the further side of the shaft. They are set at distances apart on their chains inversely corresponding to the proportionate quantities of material they are to furnish for the concrete. Below the mouth of the mixer is a third and still lower platform, upon which are two short 30-in. gage tracks, about 4 ft. apart center to center, each with one car upon it. A car upon one of these tracks is run up under the mouth of the mixer and a little to one side of its axis, but parallel

with it, and the mixer delivers continuously into its 1-yd. iron bucket (which it can fill heaping full in a minimum time of about 2 minutes) by a flat wooden chute 4 ft. wide and 6 ft. long, mounted on a horizontal axis just below the mixer and in a vertical plane through its own axis. This chute is operated like a butterfly valve, first tipped up to the angle of 45 degrees with the vertical on one side, so as to divert the flow from the mixer all into the bucket on the right-hand car. When that is nearly filled, a bucket and car are pushed up on the left-hand track. The top of the chute is revolved 90 degrees to the right, and the discharge from the mixer is instantly diverted into the empty car, and the full one is run off and taken by the derrick, which can usually swing it to the required place and empty it immediately. Sometimes hauling and the delay of materials threaten to hinder the work, and such occasions are taken to lay concrete so remote from the mixers that it takes more time or the use of two derricks to handle it. When the concrete is set, it is kept constantly well sprinkled for several days.

Architecture in London.

THAT Americans know little of architecture in London; that architecturally it is an undiscovered country; that the buildings of historical interest usually visited by tourists in London have often very small architectural value; that the present attempt by many architects "to subject us to the domination of the French" has caused the claims of current architecture in England for consideration "to be almost ignored, if not altogether overlooked"; and that there is bad taste "in neglecting work of a people from whom our ancestors descended, who speak the same language," and "who in race stand closer to us than any other,"—are charges made by Mr. Barr Ferree in *The Architectural Record* for July–Sept.

While Mr. Ferree admits that England has architecturally suffered from a variety of causes, and that even now it suffers "from a unity of purpose among its architects, from the rapid changes in the popular taste of the day, from the importation of foreign styles for a few years only, to be cast aside for something in a later fashion," yet he does England the justice to say that in that country "there has been an incredible spread of correct architectural taste, of sound artistic feeling, of a striving after better things, of an effort to renew the historical continuity that was broken in the last century."

Mr. Ferree has been considered by some rather too much of a fault-finder, but, whether this is a fair criticism or not, in this instance it is the good, not the bad, in English architecture to which he says our attention should be directed. Notwithstanding, one of the first examples of London architecture which he mentions is a specimen of the superlatively bad. After stating that "the most interesting structures in London are of very recent date," he says of Queen Anne's Mansions that though "not so old as many of the dull streets of London, they are an excellent type of this style of building; a huge group of structures ten or eleven stories high, without a single architectural idea; a monstrous pile of negation that in self-asserting commercialism, profound indifference to architectural thought, complete disregard of architectural amenities, if so they may be called, quite exceeds all other structures of the world. It is customary to twit America—and the English are perhaps the loudest in so doing—with its subservience to commercialism in architecture; yet nowhere on the face of the globe can such a terrible example be seen as this pile of London flats. It is not a type; it is rather the culmination, the final expression, let us hope, of a system of building long before applied on a smaller scale, but in quite as horrifying a manner, to miles and miles of London streets." After some more of this, Mr. Ferree follows his own advice, and gives a series of illustrations and descriptions of the "good new buildings of London." For these, brick and terra cotta are the favorite materials.

"New brick of a brilliant red is much used, though how it will stand the effects of London climate I do not know. When new, it is a very good color indeed, and

some happy combinations are obtained with trimmings of a light buff stone, almost white when fresh. Not so successful is a sort of pink terra cotta, an artificial mixture introduced by the manufacturers, and which seems to have 'caught on' without any reason for the catching. It speedily becomes faded and dirty, and is not in the least suited to London. When used alone, the effect is bad enough, but unfortunately it is often employed in combination with red brick, not unpleasing when new, and, in fact, rather startling, but excessively depressing after the pink has lost its freshness. The ease with which terra cotta adapts itself to ornamental and decorative purposes is as great a snare to London architects as it is to those in other parts of the world. Centuries of experience do not seem to have impressed the average London architect with the knowledge that the climate of his beloved city is entirely unsuited for elaborate external detail. Sooner or later detail in any material, in brick, in terra cotta, or in stone, blackens and darkens until its value is almost gone, or until what was intended as an ornament becomes a positive eyesore."

The illustrations include residences, landscape architecture, public buildings, and commercial and office buildings. A liitle, but that in high praise, is said in conclusion regarding modern London church architecture.

The Building Laws of Byzantium.

VERY early in the history of civilization it was found necessary to the safety of cities to regulate by law the construction of buildings. An interesting example of such regulation is found in the building laws of Byzantium, promulgated by the emperor Zeno in the latter part of the fifth century. Zeno's building laws commanded the admiration of Roman jurists. *The Architect* (July 13) gives an interesting epitome of this code, and an account of the circumstances under which it was put forth. Earthquakes were frequent and fires numerous. "Hordes of 'water thieves and land thieves' seemed to be always on the alert to seize everything of value which the city contained. The inhabitants, like weak animals, herded together, as if overcrowding were a source of strength. The city of London, in the old days before the Great Fire, did not present a more remarkable indifference to the laying out of streets or buildings for the common benefit. One of the Byzantine historians, who wrote in the early part of the fifth century, relates that the ground in Byzantium was insufficient for so many buildings, which were separated only by narrow lanes. Additional space could only be found by endeavoring to reclaim it from the sea by costly piling. The unfortunate inhabitants suffered equally within doors or without; they were either hampered through want of room in their dwellings, or jostled by the crowds in the close streets. When an earthquake occurs, wrote an eye-witness, the people rush out of their homes regardless of the cold or the darkness. But they find they are still in danger. The buildings are so lofty and so near each other, if they fall, great destruction of life must follow. Energetic emperors tried to cope with the evils of overcrowding, but in vain. The works for water supply and the public buildings might be remarkable, but they could not be considered as efficient remedies." When fires occurred, they were usually disastrous, owing to the overcrowding. Zeno strove to free his code of building laws as much as possible from technicalities, so that the common people, as well as the lawyers and judges, might comprehend their full import. In rebuilding and repairing no owner was allowed to change the character of a structure, and there was to be no greater interference with light and air than previously existed. A space of 12 ft. was decreed to be left between adjacent houses. Without such a space, the limit of height was 100 ft. This height was allowed in rebuilding after a fire and "in the case of houses on sites which were not used for buildings at an earlier time." But in all other cases of rebuilding the height of 100 ft. was permissible only when a space of 12 ft. was left between the new house and the houses next to it. For the sake of the wide space Zeno was willing to allow the prospect enjoyed

by a neighbor to be diminished. In other cases where high houses were erected and the open space was not less than the normal 12 ft., the disturbance of prospect was allowable only with kitchens, passages, and staircases, which were the parts rarely used for the enjoyment of views. Restrictions and limitations were imposed upon the use of timber. Contractors who desired to evade their obligations had a bad time of it. "A contractor or workman was prohibited from abandoning work before its completion." If "the work were not completed by the time agreed, compensation had to be paid to the owner for all his losses, and apparently prospective damages also. Whenever a contractor was impecunious and unable to pay for the losses and other penalties for which he became liable, he was to be flogged and expelled from Byzantium. As in our time, it was supposed to be disloyal to the craft for a new contractor to take up the work which another had left incomplete. Zeno would give no sanction to an economical theory of that kind. According to the law, if a contractor took up the incomplete work, he was bound to bring it to completion, or to incur the same penalties, including scourging, as the original contractor."

Colored Bricks.

THE liability to production of inartistic effects in the use of colored bricks in inexperienced hands is editorially considered by R. C. S. in *The Brickbuilder* for July. The writer of this editorial is announced to be "an architect of the highest professional standing," and, as such, he ought to be able to speak to the point on this matter. As to the accurate smooth red brick laid up with a fine red joint, while it is entirely suitable for certain places and certain kinds of work, a too general use has been made of it, of which it was not worthy. The tendency is now to return to the common red brick, and this material is pronounced at once economical and safe. "While it can never offer the opportunities which varied colors give, it has, at least, varied shades of color, and that color which is first-rate for exterior work. The history of architecture gives ample authority for the general use of red brick. Of the various countries which are notable for their architecture, Italy, Holland, and England give us, perhaps, the best precedent for its use. In Italy we have the splendid remains of Roman brick-work and the later brick-work of the Renaissance period. In Holland we find whole cities built of brick,—houses, shops, warehouses, and even public buildings and churches; and in England it would be hard to find any more lovely and typical examples of what is good architecture than the old red brick houses such as are scattered throughout the land."

Notable buildings constructed of common red brick are Holland House, in London, the Tower of St. Albans, the Waag at Amsterdam, the church at Dordrecht, the church of the Frari at Venice, and Santa Maria's Tower in Rome; in the United States, the Virginian Westover, or the church at Alexandria.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Architecture and Building in the American, English and British Colonial Technical Journals—See Introductory.

*686. The Architectural Students' Work Abroad. G. R. Phene Spiers (Deals with methods of study, as exemplified by different eminent architects, and with opportunities for mental cultivation and development of powers of design). Eng Mag-Oct. 2800 w.

697. Faulty Fire Escapes. Ill. Owen B. Maginnis (Inutility of most fire escapes. Favors the balcony escape). Arch & Build-Aug. 10. 500 w.

710. The Mary Hitchcock Memorial Hospital, Hanover, N. H. Ill. Edward Cowles, in "Hospitals and Asylums of the World" (Descriptive). Am Arch-Aug. 10. 2800 w.

730. Construction of the Foundations of the Cathedral of St. John the Divine. Ill. (Descriptive). Eng Rec-Aug. 10. 2000 w.

*787. An Ordinance Providing for the Creation of the Office of Inspector of Buildings, of Atlanta, Ga., Fixing his Salary, Term of Office, Duties, etc. So Arch-Aug. 6000 w.

*788. A Bill to Regulate the Practice of Architecture in the State of Georgia. So Arch-Aug. 2200 w.

We supply copies of these articles. See introductory.

804. Fall of a Building With Cast Iron Columns (Building at corner of W. Broadway and Third St., New York). Eng News–Aug. 15. 1100 w.

824. Projected Tests of Fire-proofing (Outlines the work to be done by a committee appointed by fire insurance companies, architects and engineers in an investigation of materials and methods of fire-proofing). Eng Rec–Aug. 17. 450 w.

*830. Art in Churches (Abstract of remarks by the Archbishop of York at the dedication service in Lichfield Cathedral, when some stained-glass windows were unveiled). Arch Lond-Aug. 9. 1800 w.

*831. Egyptian Discoveries. L. E. Steele, in the Irish Times (An account of the results of last winter's explorations). Arch Lond-Aug. 9. 3300 w.

835. The Style for a New Cathedral. From the Building News (Criticism of Mr. Flagg's article on the subject). Am Arch–Aug. 17. 1900 w.

840. The Lexington Building. Ill. G. B. Waite (Description of the building in which the motive power and machinery of the Lexington Ave. cable railroad is to be located). Arch & Build–Aug. 17. 1800 w.

841. The Influence of Literature on Architecture. Arthur T. Bolton (Literature, defined as thought, influences religious architecture. Reprinted from the Jour. of the Roy. Inst. of Brit. Arch). Arch & Build–Aug. 17. Serial. 1st part. 3500 w.

*844. Rudiments of a Wall. Alexander Black (A wall defined ; materials used, principles, &c). Ill Car & Build–Aug. 9. 1700 w.

*845. Old-Time Houses (American and English. Describes characteristic and typical houses of a bygone generation in both England and the United States). Ill Car & Build–Aug. 9. 1500 w.

†878. Richard Morris Hunt. P. B. Wight, with Editorial (Biographical sketch, with partial list of his important works). In Arch–Aug. 6400 w.

922. Some Details of the Ireland Building. Ill. (Evidences of the cause of the disaster). Eng News–Aug. 22. 2300 w.

969.—75 cts. The Advisability of the Registration of Architects. C. Howard Walker (Favoring legal registration and the institution of penalties for illegal use of the name; also discussing qualifications necessary). Arch Rev Vol. III., No. 7. 2800 w.

*974. Old English Homes (Descriptive). Ill Car & Build–Aug. 16. 3500 w.

*975. House Building Hints (Requisites for a pleasant, healthy home). Ill Car & Build–Aug. 16. 1000 w.

976. Steel Beam Footings—How Should They Be Used and Calculated ? (Calling attention to the probable action of beams when loaded, and to some conclusions in regard to the disposition of the beams and their calculation) Ill. F. E. Kidder. Arch & Build–Aug. 24. 2800 w.

*990. Architects' Responsibility for Extra Charges (Experience of a Liverpool Architect. Toxteth Infirmary lightning conductor). Brit Arch–Aug. 16. 2200 w.

*1009. Cracks in Brickwork and Plastering. A. H. Dyer. Ill. (What causes them and how they may be prevented). Br Build–Aug. 2000 w.

1036. Corrected Details of the Ireland Building. Eng News–Aug. 29. 1400 w.

1077. The Ireland Building Wreck, New York. Ill. (Details of points of failure). Eng Rec–Aug. 31. 4000 w.

*1145. The Japanese National Industrial Exhibition in Kioto. Ill. (Description of buildings and grounds). Am Eng & R R Jour–Sept. 2800 w.

1162. Tallest Chimneys on Earth. W. Barnet Le Van (A number of high structures with a list of chimneys over 150-ft. with the names of their builders). Mach–Sept. 900 w.

*1180. The Careless Construction and Willful Destruction of Buildings. Ill. Louis Windmüller (Accounts of some faulty constructions, calling attention to dangerous practices, and evils arising from insurance). Rev of Rev–Sept. 1900 w.

1192. Historic Architecture in Normandie. Ill. Howard Crosby Butler (Historical and descriptive). Arch & Build–Aug. 31. Serial. 1st part. 3500 w.

1195 The Sanchi Tope. Ill. J. B. Braddon (Description of the famous Sanchi Tope, in Bhopal, British India). Am Arch–Aug. 31. 700 w.

1203. Manufacture of Marbleized Slate Mantels. Ill. (Description of the process at a Jersey City plant). Sci Am–Sept. 7. 800 w.

1280. The Verdict of the Coroner's Jury in the Case of the Ireland Building (A case of great importance to architects and builders). Arch & Build–Sept. 7. 1700 w.

*1281. Architecture for the Amateur (Editorial review of book by H. Heathcote Statham). Brit Arch–Aug. 30. 1600 w.

*1282. The Design of a Column. Ill. H. Heathcote Statham (From " Architecture for General Readers, by Author). Brit Arch–Aug. 30. 700 w.

*1283. Some Defects in Modern Architectural Training. T. G. Jackson (Excerpts from address delivered at the opening of the Liverpool School of Architecture and the Applied Arts). Brit Arch–Aug. 30. 1400 w.

1284. A Series of Fireproofing Tests (Tests made under the direction of F. E. Cabot, in the presence of John S. Damrell and M. W. Fitzsimmons. Tests instituted by Willard T. Sears for the purpose of obtaining accurate data regarding the value of several different systems of fire-resisting construction). Am Arch–Sept. 7. 3000 w.

1285. Spanning Spaces. From the Building News (The problem that has been the motive of every great architectural style of the past. Review of methods and progress). Am Arch–Sept. 7. 2300 w.

We supply copies of these articles. See Introductory.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

Inland Navigation—Germany.

IN *The London Engineer* (Aug. 2) an article under the above title gives many valuable facts relating to the experience in Germany with river and canal navigation. The same journal published (Oct. 7–21, 1892) a similar article on the French inland waterways. At a time when our railroads dare cut rates no farther, when the merchant is trying to reduce all his transportation expenses to a minimum, and when several canal projects are under way, such information is particularly welcome. The article is accompanied by a map of Germany. These waterways extend from east to west through the empire, with numerous branches leading them to the ocean, thus connecting the central part of the empire and the principal shipping ports with a cheap and efficient system of transportation. After describing these routes in detail, the article continues: "Since 1880 the Prussian government has regarded the improvement of waterways for the carriage of bulky goods as of national importance, and has both regulated many of the rivers and extended the canal system. A programme was adopted at that time, and the estimated cost of completing this amounted to £4,500,000 ($22,500,000), to be spread over a period of 18 years. . . . The above amount has been supplemented by further votes to the extent of £6,200,000 ($31,000,000), making a total of £10,700,000 ($53,500,000). The expenditure in 13 years amounted to £2,354,550 ($11,772,750). The cost of maintaining German waterways in 1893 amounted to £500,000 ($2,500,000), equal to about £70 ($350) per mile. This is divisible into £60 ($300) per annum as the average expenditure on canals, while the river navigations cost £84 ($420) per mile to keep in order. . . . From a memorandum laid before the Prussian parliament in 1890, we find a statement of work done during the previous 10 years, and the result. The chief features are the greater size and carrying capacity of vessels. Canals have nearly all been opened to steamers, and steam navigation has increased considerably. In 1880 the largest vessels navigating the Rhine did not carry above 900 tons. Now they reach 1300 tons. The number of vessels has increased 25 per cent.,—6250 being employed as against 5000 10 years previously. Steamers ply between Cologne and London; also to Bremen and various Baltic ports. They are 200 ft. long, 28 ft. 6 in. beam, and have a displacement of 300 tons on a draught of 8 ft. On the Wesser the capacity of barges has been doubled from 150 tons to 300 tons and upward. On the Elbe boats are now carrying 800 tons as against 500 tons in the former period. Following the improvements, the developments of traffic have been considerable, especially on the Rhine and Elbe. The data are not sufficiently complete to admit of a trustworthy statement being framed, giving the amount of goods carried by water. If all the tonnage returns are added together, the total increase for the year 1892 above the average total for the years 1881 to 1885 would appear to be 50 per cent. This is an approximation, which, however, is borne out to a certain extent by the returns showing the number and tonnage of vessels employed at the two periods."

Here follows an itemized table, showing the character and number of vessels in 1882, 1887, and 1892, indicating that "the number of vessels under 100 tons has diminished by about 10 per cent. The number of iron sailing vessels increased from 839 in 1882 to 2707 in 1892," and there was an increase in tonnage of 66 per cent. The number of freight cars on the railroads, however, increased 30 per cent., though their capacity remained about the same. Concerning the organization the journal says: "Most of the rivers yield no direct returns, as navigation is free. The tolls levied on canals are extremely low, and there is no expectation of making them

self-supporting. The tolls are collected by the minister of finance, the expenditure comes under the public works vote, and no balancing of accounts is attempted. Approximately, the receipts from lock dues on rivers and canals amount to £67,000 ($335,000) per annum, and compares with £48,000 ($240,000) received in France. In some cases tolls have been raised of late years, but many locks are free. For instance, there are sixteen locks between Berlin and Stettin, but on only two of them are tolls levied. The general result to be gathered from the past and present condition of inland navigation in Germany appears to be that, where there is really large traffic, waterways can be constructed to pay and to compete with railways on their merits, but the traffic must be forthcoming in considerable quantity in order to pay for working expenses, maintenance and interest on money; and that, given sufficient cargo capacity, vessels can be worked from place to place much more cheaply than railway trains. The public works minister of France has stated the minimum cost of carriage at which goods traffic can be conveyed on railways so as to pay its way is 0.592 d. per ton per mile. The Belgian minister considers that in his country it should be 0.483 d. per ton per mile, whereas the Prussian minister gives the lowest remunerative charge as 0.40 d per ton per mile. Sir G. Findlay told committees that the actual cost of conveying train-loads of coal from Wigan to London and returning empty wagons amounted to 0 21 d. per ton per mile in 1870, and 0.24 d. per ton per mile in 1874. As compared with the above rates, we find that the freight for 'bulk goods' from Hamburg to Magdeburg, a distance of 187 miles, varies between .064 d. and .16 d. per ton per mile; 'various merchandise' being charged 0.32 d. to 0.51 d. per ton per mile. To Berlin, a distance of 240 miles, coal is carried at freight rates varying from 0.10 d. to 0.175 d. per ton per mile. Pig iron pays a little lower, while grain pays a somewhat higher rate. To Aussig, 417 miles, 'bulk goods' are charged from 0.144 d. to 0.18. d per ton per mile; merchandise, 0.23 d. to 0.287 d. per ton per mile. These conveyance rates would all allow of an additional toll being levied, so as to make the waterways self-supporting, and yet show a considerable reduction in the lowest remunerative cost of carriage by rail. Freights vary according to the nature of the cargo, state of the markets, and condition of the rivers. Steamers command a somewhat higher rate. Vessels navigating the waterways are variously owned by private individuals,—owners of one or more barges and steamers,—by firms owning numbers of craft, and also by important navigation companies, some with a capital of over £1,000,000 sterling. There is also an association for insuring vessels and cargoes under different classes, showing that the traffic is systematically provided for." The article then continues with a description of the funds against sickness, accident, and old age; and the statement that "canals are considered useful in Germany in relieving railways of a large amount of heavy goods traffic, and by acting as a check on railway rates."

The Ireland Building Disaster.

IN these days of tall buildings occupied by our brightest business men and filled with offices for the transaction of their affairs, the collapse of this large New York office building is significant. The fact that we live in an age of bustle is no excuse for mistakes and inefficiency in places of responsibility. Speaking of this disaster, the *Engineering News* (Aug. 22) says: "From the testimony already before the coroner's jury, and from the silent testimony given by the fractured columns and by the parts of the structure which still remain in place, it appears that the owner employed a cheap architect, who was paid only one per cent. commission on the cost of the building for his plans and superintendence; that the contractor for the structure was induced to lower his original bid about ten per cent., or $6700, to obtain the work that this contractor substituted a foundation stone of micaceous schist, or similar weak stone, for the granite called for by the specifications, and that he laid under it 12 in. of concrete, instead of 18 in., as he

agreed to do; that the contractor for the ironwork furnished columns which were of light weight, of hard and brittle iron, much thinner on one side than on the other, and full of blowholes; that the roof was enormously heavy, and, in addition, was weighted with bags of gravel; that the plasterer piled bags of plaster one above the other on the floors of the unfinished structure; that the design of the roof beam supports was defective, in that the beams rested on supporting plates of insufficient thickness and were not bolted or otherwise fastened to the columns; that the architect did not efficiently superintend the construction, did not know the existence of an old cistern in the vicinity of the foundation of the column, was not aware of the deficient thickness of the concrete bed until after the accident, and made no objection to the other defects in material or to deficient roof support; and that the city building inspector reported no faults in any of the materials or workmanship."

The roof of same construction as the floor was supported by single I-beams, four ends resting on the top of each hollow 8-in. cast-iron column with no other cap than a ½-in. bead. "On top of this, without fastening of any kind, rested a thin flat cast-iron plate about 6 in. wide by 0.75 in. thick with a flange 0.75 in. high on each side. This plate projected about 2-in. beyond the bead on each side of the column. On each end of this plate the end of one of the I-beams of the principal girder rested without fastening of any kind and in such a manner that its weight may have been brought entirely on the overhanging part of the plate. . . . It is easily seen that, if there was a slight warping of the plate or of the beam, or of both, the weight of the beam may have been brought on the extreme end of the overhanging plate instead of on a point immediately above the bead, and in that case the plate would be liable to fracture by transverse strain."

The beams resting on the ends of this cast-iron plate bore the heaviest load, rendering it sure that the slightest defect in the ¾-in. cast-iron plate would be located by a heavily-loaded beam. One of the columns in position on the eighth, or top, floor shows that this actually happened, and the released beam dropped, displacing those on the column at its other end, the whole breaking through the seventh and each consecutive floor, until it lay a dusty heap of *débris*, covering the crushed workmen beneath it. And yet such disasters are to be expected when a man employs an architect for half of what he should receive, and lets his contract to a man at a price that will ruin the contractor, for cheap work is usually poor work.

Later excavations have shown the immediate cause of the collapse to lie in the foundation of the center column. "This column [*Engineering News*, Aug. 29] originally rested on a cast-iron plate 3 in. thick, this on a stone which, instead of being granite as the specification required, was a weak, soft, micaceous schist, pieces of which could be broken off with the fingers. This stone was about 4 ft. square and 12 in. thick. It rested on a block of concrete 12 in. thick, which, according to the building laws, should have been 18 in. thick." In excavating for the concrete block the workmen came upon an old cistern reaching not quite to the center of the foundation. The soil adjacent was "practically a quicksand, composed of exceedingly fine grains of sand with considerable mica and with very little clay or loam in it." The concrete foundation, therefore, rested, one corner on a comparatively rigid foundation composed of the walls and concrete filling of the cistern, and the remainder on a wet quicksand. Mr. Chas. O. Brown, in the same issue, gives an opinion as follows: "When the concrete cracked, a certain drop must have taken place of from 3 to 4 in., giving the column an impetus, tilting the fragments of the stone and concrete, and making further progress easier. When the flanges around the base of the column cracked, another drop of 3 or 4 in. must have taken place, leaving the bare shaft of the column 15 in. in diameter with a load of 140 tons per square foot to pierce a soil which cannot be relied on to support 1½ tons per sq. ft. The center column naturally brought down

the ends of the girders resting on the same with it," and caused the breaking of the supports of the ends of the beams as described.

The Panama Canal.

IT appears that no definite plan has yet been determined upon for the proposed completion of the Panama canal, and that the main difficulties are quite as perplexing as ever before. The chief engineer of the new company has lately presented a report to the directors, which has not yet been published in full; but the London *Railway Times* quotes from a newspaper correspondent an extract from the report, which is of considerable interest. It refers to the heavy cutting at Culebra, which, in all the projects, is established for a single line of vessels; but, even with a 45° slope, the canal at the bottom would be only 21 meters wide. This the chief engineer considers altogether insufficient for large vessels (say, up to 18 meters beam), and he asks how such vessels could be moved in so narrow a space at speed enough to allow steerage way. In front of the vessel there would be a very high wave which would impede its progress. Frequent accidents would have to be feared, and also the stranding of vessels, which would stop navigation. Lastly, the banks of the canal would be seriously threatened, and landslips might occur. The technical commission, says the engineer, considered that for the commencement of the working of the canal a width sufficient for one line of vessels might be accepted; but it would be indispensable to widen it very shortly for a double line of vessels, and this improvement, the commission thought, could always be effected when necessary, as had been done for the Suez canal, and that the dilapidation of the banks could be prevented by a double facing. But M. de la Tournerie (the chief engineer) does not believe that the widening could be done without stopping navigation. In another part of the report he refers to the difficulties of controlling the torrential Chagres river, and it seems that it is still unsettled how large the relief lakes for catching the floods should be.

A Large Bucket Dredge.

THE ENGINEERING NEWS, (September 19) contains the following description of a new dredge fitted with a pulverizer used in work at the port of Libau, Russia. "The tenacious clay and marl dredged up are reduced to liquid mud by revolving steel arms and water jet, so that it can be pumped ashore through pipes by a centrifugal pump. . . . The dredge is 180 feet long, 35 feet beam, and 14 feet deep, and is fitted up with twin-screws driven by compound condensing engines of 800 I. H. P., giving a speed of seven knots per hour. One of these engines also works the dredging plant, and pulverizer, while the other works the centrifugal pump and the hauling winches. Steam is supplied by two steel boilers at 100 pounds pressure, either boiler alone being able to work the dredging machinery to its full power. The vessel is lighted by electricity. The buckets can lift about 600 tons of material per hour, and the machine has records of 6000 tons in a working day, and 62,700 tons a month raised and deposited."

The Great Sheridan Road.

PAVING AND MUNICIPAL ENGINEERING (Sept.) speaks as follows regarding one of Chicago's new enterprises. "The greatest project in roadbuilding undertaken in recent years in America is the Sheridan road, fittingly referred to often as 'the great Sheridan road.' A few public-spirited citizens of Chicago have, with admirable courage and by indefatigable efforts, brought it through the difficult stages of advancement from a supposedly unrealizable, but grand, conception to the point of assured accomplishment. How this has been done is in itself a story of the almost infinite possibilities of human intelligence and perseverance. In the beginning it was proposed that it should be a boulevard between Chicago and Fort Sheridan,—the advocates hardly dared to propose more,—but, now that the way has been blazed, after years of untiring work, through seemingly insurmountable difficulties, it is to be, in the words of a Chicago writer, '250 miles of smooth road, at times skirt-

ing the breakers of old Lake Michigan, now plunging into the forest, and again meandering through the finest farming country the sun ever smiled upon. Such is to be the future of the Sheridan road. Picture a broad highway extending from Chicago to Milwaukee; from Milwaukee through the lake dotted and river-entwined country which separates the Cream City from Lake Geneva; imagine that highway winding around the verdure-covered hills which overlook that superb body of water from the village of Geneva lake to Williams bay; continue that road across the State line until it strikes the Fox river, through Huntley, Algonquin, classic old Dundee, and beautiful Elgin, and from the city of watches follow the route familiar to all lovers of bicycling past St. Charles, Geneva, Batavia, Aurora, Downer's Grove, and Hinsdale, until it connects with the West Park boulevard system, and you will have a faint prophetic vision of the Sheridan road of the next decade. All this has been made possible by the passage of the Sheridan road bill by the Illinois general assembly and its probable enactment by the Wisconsin legislature. It provides for the creation of park districts and the control of submerged lands and those bordering on navigable bodies of water. Through the creation of these park districts and the acquirement of land by condemnation for the purpose, a way is opened for the road, and its construction and maintenance provided for. The bill is a long one, and is a good model for similar projects in other States." The movement originated in 1887 at the home of a Chicago citizen, and is headed by Mr. Volney W. Foster as president of the Sheridan Road Association. Though the original purpose was to construct a pleasure drive from Chicago to Fort Sheridan, there was so much encouragement shown to the enterprise that it has grown to the magnitude indicated. Active construction is in progress on "almost every section between Chicago and the Wisconsin State line." Governor Altgeld is reported as saying that "the Sheridan road is one of the great achievements of the century. There will not be such another road in the world, and it will bring a harvest of honor to the men who are giving it time and effort."

Standard Specifications for Structural Steel.

IN the struggle for standards by universal agreement, the following specifications, setting forth what the manufacturers have agreed upon, are a big step. The Steel Manufacturers' Association, which adopted it, is composed, according to *The Iron Age* (Sept. 5), of "the Illinois Steel Co., Carnegie Steel Co., Jones & Laughlins, Carbon Steel Co., Cambria Iron Co., Penna. Steel Co., Pottstown Iron Co., Shoenberger Steel Co., Spang, Chalfant & Co., Otis Steel Co., Ltd., Cleveland Rolling Mill Co., and others.

"SPECIFICATION.

"*Process of Manufacture.*—1. Steel may be made by either the open hearth or bessemer process.

"*Test Pieces.*—2. All tests and inspection shall be made at place of manufacture, prior to shipment.

"3. The tensile strength, limit of elasticity, and ductility shall be determined from a standard test piece cut from the finished material and planed, milled, and turned parallel. The elongation shall be measured on an original length of 8 in., except when the thickness of the finished material is $\frac{5}{16}$ in. or less, in which case the elongation shall be measured in a length equal to sixteen times the thickness; and except in rounds of $\frac{5}{8}$ in. or less in diameter, in which case the elongation shall be measured in a length eight times the diameter of section tested. Two test pieces shall be taken from each melt or blow of finished material,—one for tension and one for bending.

"3 *a*. Material which is to be used without annealing or further treatment is to be tested in the condition in which it comes from the rolls. When material is to be annealed or otherwise treated before use, the specimen representing such material is to be similarly treated before testing.

"4. Every finished piece shall be stamped with the blow or melt number; and steel for pins shall have the blow or melt num-

ber stamped on the ends. Rivet and lacing steel and small pieces for pin plates and stiffeners may be shipped in bundles securely wired together, with the blow or melt number on a metal tag attached.

"*Finish.*—5. Finished bars must be free from injurious seams, flaws, or cracks, and have a workmanlike finish.

"*Grade of Steel.*—6. Steel shall be of three grades,—rivet, soft, and medium.

"*Rivet Steel.*—7. Ultimate strength, 48,000 to 58,000 lbs. per square inch. Elastic limit, not less than half the ultimate strength. Elongation, 26 per cent. Bending test, 180 degrees, flat on itself, without fracture on outside of bent portion.

"*Soft Steel.*—8. Ultimate strength, 52,000 to 62,000 lbs. per square inch. Elastic limit, not less than one half the ultimate. Elongation, 25 per cent. Bending test, 180 degrees, flat on itself, without fracture on outside of bent portion.

"*Medium Steel.*—9. Ultimate strength, 60,000 to 70,000 lbs. per square inch. Elastic limit, not less than one half the ultimate. Elongation, 22 per cent. Bending test, 180 degrees, to a diameter equal to the thickness of piece tested, without fracture on outside of bent portion.

"*Pin Steel.*—10. Pins made from either of the above-mentioned grades of steel shall, on specimen test pieces cut at a depth of 1 in. from surface of finished material, fill the physical requirements of the grade of steel from which they are rolled for ultimate strength, elastic limit, and bending; but the required elongation shall be decreased 5 per cent.

"11. Eye bar material, 1½ in. and less in thickness, made of either of the above-mentioned grades of steel, shall, on test pieces cut from finished material, fill the physical requirements of the grade of steel from which they are rolled. For thickness greater than 1½ in. there will be allowed a reduction in the percentage of elongation of 1 per cent. for each ½ in. increase of thickness to a minimum of 20 per cent. for medium steel and 22 per cent. for soft steel.

"*Full-Size Test of Steel Eye Bars.*—12. Full-size test of steel eye bars shall be required to show not less than 10 per cent. elongation in the body of the bar, and tensile strength not more than 5000 lbs. below the minimum tensile strength required in specimen tests of the grade of steel from which they were rolled. The bars will be required to break in the body, but, should a bar break in the head, but develop 10 per cent. elongation and the ultimate strength specified, it shall not be cause for rejection, provided not more than one-third of the total number of bars tested break in the head; otherwise the entire lot will be rejected.

"*Variations in weight.*—13. The variation in cross-section or weight of more than 2½ per cent. from that specified will be sufficient cause for rejection, except in the case of sheared plates ordered to gage; in which event there will be permitted an excess of weight over that corresponding to the dimensions on the order equal in amount to that specified in the following table:

TABLE OF ALLOWANCES FOR OVERWEIGHT FOR RECTANGULAR PLATES.

Width.	Per cent. allowance for given thickness of plate in inches.							
Thickness in inches.....	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	over $\frac{3}{4}$
Up to 75.....	10	8	7	6	5	$4\frac{1}{2}$	4	$3\frac{1}{2}$
75 to 100.....	14	12	10	8	7	$6\frac{1}{2}$	6	5

"*Specifications for Structural Cast Iron.*—1. Except where chilled iron is specified, all castings shall be tough gray iron, free from injurious cold shuts or blow holes, true to pattern, and of workmanlike finish. Sample pieces, 1 in. square, cast from the same heat of metal in sand molds, shall be capable of sustaining on a clear span of 4 ft. 8 in. a central load of 500 lbs. when tested in the rough bar."

In the grading of the steel an "extra soft steel" was included, having an ultimate strength of 45,000 to 55,000 lbs. per square inch, and an elongation of 28 per cent. This steel is used for such purposes as boiler rivets. The above is interesting as showing the manufacturers' idea of a specification. As will be seen, there is a great deal of latitude allowed, no mention being made of composition or of guaranteeing the tests; nevertheless, it represents pretty closely actual practice at the works,

where specifications are not furnished by the purchaser.

The Effect of Artificial Diversion upon the Commerce of the Lakes.

SINCE the inception of the various plans to utilize water from the great lakes through diversion into other channels than those occupied during historic times, much speculation has resulted as to the effect of such diversion upon lake traffic and upon the falls of Niagara. *The Iron Age* of July 4, in an editorial entitled "The Chicago Canal and Lake Commerce," says, basing the remarks upon data prepared by C. H. Keep, secretary of the Lake Carriers' Association: "A lowering of the lake levels by 3 in. would produce a diminution of the carrying capacity of the lake fleet in a season amounting to 1,142,370 tons; a lowering of the lake levels by 6 in. would diminish the carrying capacity 3,427,110 tons." It estimates that the money loss due to a lowering of 3 in. would amount to $571,185, and that due to a lowering of 6 in. to $1,142,370. It is estimated by Thomas T. Johnson, of the Chicago drainage canal, that the latter, when taking its maximum capacity, will lower the level of Lake Michigan between 5 and 6 in. The editor thinks that, in view of the wide fluctuations in the levels of the great lakes due entirely to natural causes, the accuracy of calculations of this kind may be questioned.

Pipe Line for Clay.

THE staple industry of the neighborhood of Sittingbourne, England, is brick-making, and a firm there, says *Brick*, for August, has just bought 45 acres of brick earth at Highsted. The clay will be washed on the spot and will be conveyed by means of pipes to the works belonging to the firm at Murston, a distance of 2 miles.

This enterprising firm has for some years taken their supply of clay from Tong, at about an equal distance, whence, after washing, it was piped to their works, so the system is by no means an experiment.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Technica Journals—See Introductory.

Bridges.

*721. New Stiffened Suspension Bridge over the Danube. Ill. (Competition designs). Eng, Lond–Aug. 2. 1000 w.

729. Hydraulic Field-Riveting in France. Review of article by M. Geoffroy. Eng Rec–Aug. 10. 750 w.

*858. The New Waverley Bridge, Edinburgh. Ill. (Details of structure. Descriptive). Eng, Lond–Aug. 9. 2500 w.

*1028. Wooden Bridge Construction on the Boston and Maine Railroad. Ill. J. Parker Snow (Read before the Boston Society of Civil Engineers. Description of present practice with detail drawings). Jour Asso Eng Soc–July. 5500 w.

*1081. Rutherglen Bridge (Illustrated with views and drawings. Will bridge the Clyde with three spans). Eng, Lond–Aug. 23. 2500 w.

1208. The Reactions of Partially Continuous Drawbridges. Mansfield Merriman (A paper read before the Section of Mechanical Science of the Am. Asso. for the Advancement of Science. A thoroughly general scientific discussion with development of formulæ). Eng News–Sept. 5. 1500 w.

1209. Determining the Deflection of Swing Spans (Short, concisely stated method for calculating strains and deflection of drawbridge spans). Eng News–Sept. 5. Table.

1270. A Standard Combination Highway Bridge. Ill. (A combination Pratt truss with steel tension and wood compression members, outline specification, and details of fastenings, etc. Especially adapted for western territory). Eng Rec–Sept. 7. 850 w.

Canals, Rivers and Harbors.

*720. Inland Navigation—Germany. Map (Describing rivers and canals; statistics of traffic). Eng, Lond–Aug. 2. 3500 w.

765. The New Canal at Sault Ste. Marie. Ill. (Descriptive application of electrical machinery for operating the lock gates and valves of canal lock). Can Elec News–Aug. 4000 w.

802. Sounding Boat Used on the Danube River Improvement. Ill. (A system of sounding that determines the contour of the river bed with an accuracy which has probably never been equaled). Eng News–Aug. 15. 700 w.

*861. Opening of the Southampton Graving Dock (Picturesque ceremony). Trans–Aug. 9. 4000 w.

918. The Proposed New York-Philadelphia Ship Canal (Report upon the progress made and including the official reports of N. H. Hutton

We supply copies of these articles. See Introductory.

and L. M. Haupt). Eng News–Aug. 22. 1100 w.

1034. The Swan Lake Reservoir and Canal System, Utah. Ill. W. P. Hardesty (Description with map and illustrations of new form of headgate). Eng News–Aug. 29. 3000 w.

1038. The Proposed Atlantic Coastwise and Cape Cod Canals. Ill. (A short route from Boston to Philadelphia involving a canal across Cape Cod peninsula and across New Jersey. Map and sections). Sci Am–Aug. 31. 800 w.

*1137. The Ship Canal and Its Prospects (Financial condition and prospects of the Manchester Ship Canal). Trans–Aug. 23. 1200 w.

*1190. The Manchester Canal (Statement of financial condition). Ir & St Tr Jour–Aug. 24. 500 w.

1204. Dredging and Floating Pipe System. Ill. (Description of pipe, with flexible joints, used on the North Sea Canal). Sci Am–Sept. 7. 600 w.

1211. Concerning the North Sea and Baltic and the Suez Ship Canals. E. L. Corthell (Brief description with revision of details up to date). Eng News–Sept. 5. 1100 w.

*1237. Description of the Harbor of Batavia. Ill. M. G. de Gelder (A full description of the plan and work in dredging and removing coral banks with cost and capacity of machines used. Work was done by the Dutch government at a cost of £1,548,000). Eng, Lond–Aug. 30. 2200 w.

*1278. Harbor Construction in Spain (A scheme to improve the harbor of Bilbao, consisting of a breakwater 1600 yards long, and a countermole which will form an outer harbor). Trans–Aug. 30. 2000 w.

Hydraulics.

910. Pumping Water by Compressed Air. Ill. (An account of the Pohlé system, which has been introduced into Canada by the Ingersoll-Sargeant Drill Company, of Montreal). From the Can Eng. Sci Am Sup–Aug. 24. 1000 w.

911. Pumps and Pumping Machinery. William Perry (Historical). Sci Am Sup–Aug. 24. 3000 w.

919. Hydraulic Shield for the Blackwall Tunnel under the Thames. Ill. (Descriptive). Eng News–Aug. 22. 1400 w.

†1141. The Pelton Water Wheel. Ill. (The report of the Franklin Institute, through its Committee on Science and the Arts, on the invention of Lester A. Pelton, with appendix of historical notes and data by the sub committee). Jour Fr Inst–Sept. 10500 w.

1272. The Economic Velocity of Transmission of Water Through Pipes. George W. Tuttle (The results of original investigations on the most economic relation between diameter and velocity of water in pipes with derivation of formulæ in which cost enters as an item. A valuable contribution). Eng Rec–Sept. 7. 1500 w.

Miscellany.

*694. The Newhouse Tunnel at Idaho Springs. Ill. Arthur Lakes (A notable mining enterprise). Eng Mag–Oct. 3700 w.

771.—75 cts. A Discussion of State Legislation on Highways in the United States. Roy Stone. Tech Quar–April. 5800 w.

823. Subaqueous Tunnel Work.—The Hudson River Accident. J. F. Anderson (Gives particulars relating to this accident and of circumstances which led up to it, not before published). Eng Rec–Aug. 17. 3000 w.

*846. The Abuse of Cement. D. B. Butler. (Treatment often the cause of failure; inattention to setting properties; dirty aggregate; proper maturing before use; protection from extremes of temperature). Ill Car & Build–Aug. 9. 900 w.

888. A Costly Feature of Canal Navigation. (Loss of time, caused by breaks, and losses in consequence). Ry Age–Aug. 16. 2000 w.

920. Formulas for Long Columns. A. J. Du Bois (A new rational formula that includes all the others as special cases). Eng News–Aug. 22. 2800 w.

*931. The Severn Tunnel. Leveson Francis Vernon-Harcourt (From brief notices of works published by the Inst. of Civ. Eng.) Col Guard–Aug. 16. 1200 w.

*1026. Timber-Preserving Methods and Appliances. Ill. W. G. Curtiss (A description of a portable wood-preserving plant recently put into successful use on the Pacific System lines of the Southern Pacific Company). Jour Asso Eng Soc–July. 8000 w.

*1029. The Engineering History of a Law Suit Respecting a Contract for Railroad Building in South Dakota. Francis C. Tucker (Read before the Boston Society of Civil Engineers. An interesting paper. Decision of the Court). Jour Asso Eng. Soc–July. 4800 w.

1039. The Boston Subway. Ill. (Description of the four track underground trolley line now being built in Boston). Sci Am–Aug. 31. 1100 w.

*1104. The Great Sheridan Road. Ill. (The greatest project in road building undertaken in recent years in America. A pleasure drive of 250 miles out of Chicago). Pav & Mun Eng–Sept. 1600 w.

*1105. Important Facts Regarding Cement and Its Use (An epitome of the practice in the use of cement). Pav & Mun Eng–Sept. 1000 w.

1156. Standard Specifications for Structural Steel (Adopted by the Steel Manufacturers' Association, which includes the principal manufacturers of the United States). Ir Age–Sept. 5. 1200 w.

1271. Details of Construction of Engineering Structures. C. C. Schneider (Reprinted from Trans. of the Asso. of Civ. Eng. of Cornell Univ.) Eng Rec–Sept. 7. Serial. 1st part. 2000 w.

1294. Improvement of Highways by Convict Labor. Roy Stone (Advocating the system showing that it would be economical, and showing how it may be done. Also advocating steel rails for wagon use to reduce traction). Ry Rev–Sept. 7. 1700 w.

We supply copies of these articles. See introductory.

DOMESTIC ENGINEERING

Sanitary Plumbing.

A LECTURE delivered by Cesare J. Marani before the Engineering Society of the School of Practical Science, Toronto, and printed in *Domestic Engineering*, is instructive. The attitude of the common run of architects toward this class of work is discussed in the first part of the lecture, and it is asserted that the average architect possesses little or no scientific knowledge whatever on the important subject of sanitary engineering, thus clearly demonstrating that "he and the rest of the profession attach too little importance to their responsibilities in connection with the plumbing of buildings, and therefore do not seem to experience for this that feeling of personal accountability, so essential to success, which they do for other and less important sections of their work."

Mr. Marani does not refer to the average member of architects' associations, but the average of all who are practising architecture, a great many of whom have not the qualifications and attainments that would enable them to gain a membership in a respectable architectural club; and in this connection he quotes Colonel E. Waring as saying:

"I have never applied a water test, under pressure, to work that has been done in a fine house under control of an architect with any other result, so far as his frame of mind was concerned, than to annoy him by the demonstration of leaks and defects.

"What seems still more remarkable, when I have sometimes thought that I had an architect really converted, when he acknowledged the work to be simple, elegant, safe, cheap, and in every way satisfactory, is that the conversion never lasted. I never found that the example had the slightest influence on him afterwards."

While outlays that will *manifestly* add to the comfort or luxury of a house are not seriously objected to, such as will secure its sanitation without show, or promise of immediate personal ease or comfort, are objected to. Not only this "ostrich-like policy, but the pandering to it on the part of architects, is to be regretted."

A case is cited wherein an architect justified himself for paying no attention to plumbing details on the ground that "he had employed the best plumber in the town" to do the work, and that therefore the work would be certainly done well. "But," asks the lecturer, "who constitute the best practical plumbers" in a community? "Are they men of science as well as clever mechanics? Are they fully entitled by a sound experience and careful study of their trade to the full import of such an appellation? I fear not, and certainly much less to that signification which a too confiding public is ever sure to place on such titles. It is a fallacy to imagine that the knowledge of how to handle, cut, and connect pipes, and wipe joints, of necessity makes a man master of the plumbers' trade. And yet I have known from experience that in the great majority of cases this is regarded as the criterion. It might seem that the impression prevails among a large class of pipefitters and mechanics that the possession of a certain number of working tools, together with the valuable assistance of a couple of incompetent 'shop boys,' a large shingle suspended over the sidewalk, more pronounced in its economy for truth than expense, a few cast-iron connections displayed just outside the shop, and lots of gas-brackets and other brass fixtures inside, constitutes a man at once a practical plumber. There are a great many good workmen who are by no means practical plumbers and sanitary engineers, as they often style themselves."

The architect is therefore inexcusable for leaving plumbing work wholly to the assumed knowledge, skill, and fidelity of the "best plumber in the town." He him-

self ought to have the theoretical knowledge to be able to see that no principle of good plumbing is violated; then, if he pleases, he may rest in the belief that the best plumber in town will be able to make a tight job, which will stand a test under his supervision. What "the best plumber in town" can sometimes do is illustrated by the following instance:

"Not very long ago a case came under my notice in this city, where a long vertical line of soil pipes had choked and blocked up completely. It was thought, at first, that the servants must have thrown rags, etc., down the closets, but further examination showed that there was nothing in the pipes, save the legitimate house waste and closet paper.

"The plumbers, in erecting the said line of pipes, had used too little gaskets in some of the joints, and none at all in others. The consequence was that the lead intended for the joints had spurted inside, in some cases forming regular groups of fingers across the pipes, thus obstructing the passage of paper, etc. The only way this could be rectified was by the tearing down and reconstructing of that vertical line of soil pipes."

The "unit of sanitary adminstration" is the house. "In fact, the whole system beyond, with its many intricacies and problems, both mechanical and financial, never would have been developed, nor ever have sprung into existence, but for the dwelling."

Effects upon Health of the Products of Gas Combustion.

PROFESSOR H. CHR. GEELMUYDEN has contributed to *Archiv für Hygeine*, 1895, Vol. XXII, No. 2, an account of an investigation carried out by him as to the effects upon health of the products of gas combustion, and as to the presence of these products where gas is used as an illuminant, etc. This account having been copied in *Journal für Gasbeleuchtung*, *The Gas World* (July 6) prints an abstract of it. The experiments were performed in the laboratory of the Physiological Institute of the University of Christiania, and occupied 6 months. The necessity for the experiments is explained by the fact that recorded results of older experiments cannot be assumed to apply to products of combustion of gas produced by newer and improved methods, and that in different locations and with different qualities of coal the composition of illuminating gas varies, even when manufactured substantially by the same process. "Much of the older work had therefore to be gone over again; and the result showed that it was well to have done so. Gas, if it escapes from the pipes, is, of course, a powerful poison; but the question here was as to its products of combustion; and in this investigation it is limited to the products of the combustion of gas when it is used as a lighting agent, not when used for heating or for cooking in confined rooms. In these cases the products of combustion, whatever they may be, should always be taken off by a chimney, and therefore do not come into the question at all. In most cases of lighting, on the other hand, the products of combustion escape into the room; and that is the case now inquired into."

The question to be solved in these experiments was not whether gas burned in "old-fashioned or worn-out burners is prejudicial to health," but whether the average gas, burned in really good burners, is so. "The answer is favorable to gas." The gas used was Christiania gas; the results might be different, particularly as regards the sulphur compounds, if the gas of some other town were tested. Christiania gas is, according to the gas-works chemist, Herr Mejländer: hydrogen, 47 per cent., by volume, CH_4, 36; heavy hydrocarbons and benzol, 4; CO, 8; CO_2, 2; N, 2 to 3; sulphur, in all forms, from 304 to 347 grains per 1000 cu. ft. When such a mixture as this is burned, the products are, along with a little nitrogen, carbonic acid and water vapor, with some sulphurous acid, which soon becomes sulphuric acid in damp air, and also traces of nitrogen-oxygen compounds, which experiment has shown to be always produced in every case of combustion in atmospheric air. "Imperfect combustion may lead to the formation of other products. Then there

may possibly be other constituents in coal gas, not usually sought for, or difficult to detect; and these, though not affecting the heating or lighting value, might be hygienically of importance; for instance, arsenic might possibly be present. To hunt out every possible component of the products of combustion by itself would be an endless task. But the problem became a simpler one when once it was ascertained that in good ordinary burners combustion is complete; and the question became practically one for carbonic oxid, arsenic acid, hydrocyanic acid, ammonia, and nitrous acid and other oxygen-compounds of nitrogen."

The experiments were made with "the ordinary slit burner, the argand burner, and the Welsbach burner." It is easy to collect the products of combustion from either of these types of burners. The chemical tests applied for the analysis of these products would interest only chemists. We shall review only the results. With both the slit burner and the argand burner "no volatile, neutrally-reacting, unburned compound of carbon, such as hydrocarbon or carbonic oxid, is liberated on combustion." With Welsbach burners some carbon in the form of hydrocarbons and carbonic oxid does get through; and this was found to be uniformly the case under all the conditions by which it was sought to prevent their occurrence. The quantities of these products were, however, so small that by no conceivable possibility could they become harmful. We may, therefore, consider all these types of burners, when in good condition, as perfectly innocuous so far as generation of carbon compounds is concerned.

The only volatile acids found were carbonic and sulphurous acids. A special search for hydrocyanic acid gave only negative results, and not the slighest trace of arsenic was detected. The sulphurous acid was also considered to be so small in quantity as theoretically not to be in any degree noxious; but, to make assurance doubly sure, the chemical tests were followed by physiological tests on small animals (mice), which breathed for 3 days the atmosphere containing the products of combustion without any signs of discomfort. The blood of these animals, upon analysis after such exposure, showed no traces of the absorption of harmful products. Experiments of Mr. Novik, at the Christiania gas-works, have proved that, "if there be no escape of gas, and if the burners be steatite and not of iron, the growth of plants in a room lit by gas is unexpectedly good. In fact, a fine floral display has been maintained in the gas-lit offices of the Christiania gas-works."

Ventilation and Heating of Schools.

In a paper on the above subject by Professor O. L. Miller, read before the Sanitary Convention last November, and reprinted in *Architecture and Building*, the author maintains that 2000 cu. ft. per hour for each pupil should be supplied. This amount is advocated at the present time by the highest authorities on school hygiene. Of course this amount is to be supplied in summer as well as in winter; but in winter the air-supply will require to be warmed before being forced into the apartment to be ventilated. Professor Miller is an advocate of downward ventilation, and he gives the following reasons for his preference. "If, however, nature has found it wise to place barriers to dust at the entrances of our bodies, is it not worth while to assist her? This principle leads us to place the outlets at the floor level, and the inlets in the wall several feet from the floor. Two other objects are also accomplished. The inlets do not collect as much dust as they would if placed in the floor. The air is taken from the floor, where the air is longest in the room and therefore the most impure air collects. Second, the air in contact with the windows and outside walls being cooled most rapidly, we should place the outlets near those walls; otherwise currents of cold air may be noticeable near the floor."

The fact that it is unsafe to regard two rooms as equally ventilated because they have the same areas of inlet and outlet cross-sections is pointed out. This error is not unfrequently made. The distance the air must move in the flues, the form of the flues, and the number of bends in the pass-

age will, independently of the area of cross-section, greatly influence the flow.

"Undoubtedly the most frequently violated and at the same time the most important principle is that the outlets from each room should open into separate ventilating shafts. Adherence to this principle is absolutely essential to satisfactory ventilation. If several rooms ventilate into a common shaft, the moment the equal pressure of air in those rooms is destroyed, as by the opening of a window, that moment there is danger and probability, not only that the foul air from some of those rooms will not be drawn out at the usual rate, but that foul air from this common shaft may be actually forced into some of the rooms. The common ventilating shaft may in this way be the means of spreading disease germs from one room to another."

The best systems and apparatus for ventilating may fail of efficacy through faults in management. "It is quite generally recognized that the outlets are not to be closed, but it seems to be forgotten that the closing of the inlets cuts off our supply of fresh air. It should be impossible to close the inlets. Protection from too high a temperature should be secured in two ways. First, the janitor should exercise care and judgment in the control of fires. Not precisely as hot a fire should be built on a mild spring day as on a cold winter day. Second, there should exist an arrangement, under the control of the teacher, of such a nature that cold fresh air could be admitted directly into the warm-air inlet pipe. Thus the volume of fresh air entering into the room is not diminished, but its temperature is lowered."

In conclusion, all direct heating in school-rooms, whether by steam or hot-water, is condemned. Indirect locating should always be employed.

An Alleged Remarkable Discovery in Gas.

THE substance of the following statement, which, until it is further confirmed, had, perhaps, better be taken with some grains of allowance, is made in *Domestic Engineering* for August. It relates to an alleged French discovery in gas-lighting, which, it is claimed, places the latter in a position to compete with electricity without any reservations, and which is said to be the invention of M. Denayrouse, a French scientist. The new method, it is said, was exposed by M. Mallet at a recent meeting of the Société Technique de l'Industrie du Gaz. In making the invention "M. Denayrouse had first been struck with the idea of applying the principle of the blow-pipe to the gas burner; and, instead of increasing the heat, he sought to increase the lighting power. He employed a lamp with a spherical-shaped metallic body and an incandescent mantle. In the body of the lamp is placed a very small dynamo working a ventilator and receiving the current from a couple of tiny accumulators. The electrical energy generated is exceedingly small, and is only about one-third volt and one-tenth ampere. This, however, is quite sufficient to force a current of air through the mantle, and to cause the gas to burn with remarkable brilliancy. M. Mallet then lighted the lamp, and the result was so surprising that the members broke out in cheers."

"The lamp," said M. Mallet, "has a power of thirty-five to forty carcels, and the lamp consumed 7 liters of gas per carcel." He had, however, been shown a lamp of eighty carcels, and he was convinced that it was quite as brilliant as the arc lamps, few of which attained this power. For lighting open spaces he thought that the time was not far distant when gas would entirely supplant electricity, and the arc lamp would have to come down from its high pedestal.

Instead of enemies, gas and electricity would be sisters. In the electrical cables and gas conduits of the cities there was enormous illuminating energy hitherto unsuspected. As to the practical character of the lamp he would say nothing until he had had an opportunity of putting it to the test, but he could now say that the lamp was very simple of construction and very safe to use. The suppression of the glass was quite unexpected, even to himself. M. Denayrouse was warmly complimented by the members for his remarkable invention. The carcel lamp here referred to is named from its inventor, M.

Carcel. It supplies oil to the wick by a small pump operated by clockwork. A form of this lamp, in which a ventilator is operated by clockwork, thus supplying draft without a chimney, was put on the market, in the United States a few years ago.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Domestic Engineering in the American, English and British Colonial Technical Journals—See Introductory.

Heating and Ventilation.

698. Ventilation and Heating of Schools. Extract from paper by O. L. Miller (General movement of the air should be downward; Outlets near outside walls; opposed to heating by direct radiation). Arch & Build-Aug. 10. 1600 w.

*867. Failures of Heating Boilers (Editorial review of Board of Trade report on failures during winter of 1894-5). Prac Eng-Aug. 9. 1400 w.

914. Low Pressure Steam Heating Apparatus. Ill. James Mackay (One pipe gravity return). Mas Steam Fit-Aug. 1000 w.

915. Drainage of Heating Coils and Steam Pipes in Sugar Houses. Allahassett in La. Planter (Means principally used; suggestions, etc). Mas Steam Fit-Aug. 1900 w.

966. Heating in a Washington Residence. Ill. (Diagrams of plans; method of computing heating surface, etc). Eng Rec-Aug. 24. 1200 w.

968. Heating Notes and Data (Extracts from a report of J. H. Kellogg, M. D. to the Michigan State board of health. A résumé of important and essential points to be observed to secure successful results in heating and ventilation). Heat & Ven-Aug. 15. 1500 w.

970. Heating with the Open Fireplace. Will Walter Jackson (Only about 10% of heat is received in the room). Am Arch-Aug. 24. 800 w.

1256. Calculating Chart for Area of Indirect Ducts; and Effective Area of Registers. J. L. Bixby, Jr. (With explicit explanation and directions for use). Met Work-Sept. 7. 700 w.

1273. The Jefferson Hotel, Richmond, Va. (Detailed description of the heating, water supply, steam power, and electric lighting plants). Eng Rec-Sept. 7. 3300 w.

Landscape Gardening.

766. Color in the Garden. Editorial (Deals with the color schemes of beds and borders). Gar & For-Aug. 14. 1400 w.

909. Covered Ways of Hardy Fruit Trees. Ill. (Cultivation of trees for shade as well as fruitage). From The Garden. Sci Am Sup-Aug. 24. 500 w.

1015. The Treatment of Small Seashore Places. Editorial (Simplicity the quality desired). Gar & For-Aug. 28. 1300 w.

†1043. Aquatic Gardening. Ill. J. H. Connelly (Water-plant culture for the estate, the garden, and the house). Cent Mag-Sept. 6000 w.

1196. The Architectural Attack on Rural Parks (Extract from letter by Frederick Law Olmstead, with editorial comments). Gar & For-Sept. 4. 1200 w.

Plumbing and Gas Fitting.

*773. A New Incandescent Gas-Lighting System (Ver-Stracten's System. Descriptive). Jour Gas Lgt-Aug. 6. 900 w.

*872. Sanitary Plumbing. Ill. Cesare J. Marani (Lecture delivered before the Eng. Soc. of the School of Prac. Science, Toronto). Dom Eng-Aug. 2400 w.

*873. A Remarkable Discovery in Gas (Describes a combination of a gas-burner and mantle with a small dynamo in the lamp for supplying air for combustion). Dom Eng-Aug. 500 w.

*874. Antiquated Plumbing (Criticises the retention of antiquated plumbing in city public buildings, and sets forth the obstacles which prevent introduction of modern improved methods and appliances). Dom Eng-Aug. 1300 w.

906. Plumbing a Tall Office Building (Complete specifications for the plumbing of the 25-story building of the American Tract Society in New York). San Plumb-Aug. 15. 8500 w.

965. English Views Concerning Main Traps on House Drains (Abstract of a report by T. de Courcy Meade, engineer of the local board of Hornsey, one of the suburban districts of London, approving the use of such traps). Eng Rec-Aug. 24. 2500 w.

1125. The Flow of Gases and Proportioning Gas Mains (Original diagrams with explanatory notes, etc). F. S. Cripps. Pro Age-Sept. 2. Serial. 1st part. 700 w.

*1224. Incandescent Gas Lighting (An account of an interview with Julius Moeller, inventor of the system improved by Welsbach, relating to the past, present and future of incandescent gas lighting, with a portrait of Moeller taken by Welsbach light). Gas Wld-Aug. 31. 2800 w.

1258. Modern Bath Rooms (Describes a number of luxurious bath rooms in the most recent examples of costly residences erected in the United States). San Plumb-Sept. 1. 800 w.

Miscellany.

*871. Selling Hot Water. Ill. (System in vogue in Paris). Dom Eng-Aug. 600 w.

*1002. The Best Way to Burn Gas for Lighting Purposes. C. R. Bellamy (A very instructive lecture to users of gas, pointing out the practical economies possible in the use of gas for illumination, and showing how the same amount of illumination may cost more to one consumer than to another, through neglect of due attention to these practical economies). Gas Eng Mag-Aug. 10. 2800 w.

We supply copies of these articles. See Introductory.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading and Domestic Engineering.

The Wiring of Buildings.

IN the *Electrical Engineer* (Aug. 7) A. E. Dobbs has a very suggestive and valuable contribution, in which the merits and demerits of different methods of interior wiring and wire-protection are discussed. He points out that the weak spots in all wiring systems, both as to insulation and resistance, are to be looked for at the outlets. In a long experience he has observed but very few instances of trouble in the runways. The loop system is objectionable because there are four wire-ends to deal with at each outlet instead of two, and hence there is great liability to the introduction of an abnormal increase of resistance by reason of neglect of proper soldering. Theoretically, the interior conduit system is a good one; but, as the author pertinently remarks, "there is no use arguing what the system would do if properly installed. The most specific directions and lectures as to the proper mode of installation will not help a careless wireman, or alter the financial aspects of the case to a contractor who has been compelled to 'figure close,' and who tries to save all he can on the labor account." While highly commending the modern iron-armored conduit for all first-class work, Mr. Dobbs suggests a plan for the cheap and safe wiring of wooden houses of moderate cost, such as are found in most towns and villages in the United States, which appears to possess merit. Weather-proof triple-braided wire, saturated with asphaltum compounds which mice will not meddle with, has been found to give good service in this class of work, though sometimes objected to by insurance inspectors. The wires are run through the central openings of ordinary porcelain knobs stapled or tied to the joists and studding, porcelain bushings of ample size being used in passing through timbers. At the outlets, porcelain tubes with at least a 3/8-in. hole are employed, both wires of a loop being pulled through the same tube. The wires are drawn through from one outlet to another, as in the conduit system. The matter of the inexpensive and at the same time safe wiring of small houses is an important one, and we are glad to note that some attention is being given to it by well-qualified experts.

The Chicago-St. Louis Air Line.

AS long ago as May, 1893, in commenting in this department on the extensively circulated prospectus of the Chicago and St. Louis electric air-line, we remarked that it had always been impossible for electrical men to regard the project seriously, and that the undertaking did not appear to be founded upon anything substantial, unless it might be human credulity. The general public, and even many of the technical journals,—which ought to have known better, and, in fact, did know better,—were apparently unable to see anything in the least out of the way in the offer to sell a stock, alleged to be absolutely certain to earn 29 per cent. (exact figures) per annum, at 60 per cent. of its par value. Now, to use an expressive colloquialism, it appears that the scheme has "gone up," although it is only a few weeks since the chief promoter of the swindle announced that nine out of the ten million dollars needed to complete the road had been raised, and that, inasmuch as "the bankers were under a constant daily forfeit to raise the balance, the ultimate success of the enterprise was assured." *Electricity*, which, like THE ENGINEERING MAGAZINE, has not failed to tell the truth about the scheme, in its issue of July 24 says that "the episode now ended may seem to the superficial like a huge joke. It is nothing of the kind. Several hundred people who have bought stock and lost their money will forever associate all electrical investments with the great Chicago-St. Louis Air Line. And why should they not?" Nearly all the other electrical journals treated the

matter seriously, and discussed it as if there was really something in it. But there are plenty of other electric railway schemes at this moment appealing to the public for capital which are not one whit better, intrinsically, than the defunct air-line, the promoters of which have collected and dissipated $112,000, according to newspaper accounts.

Poles, Wires, and Shade Trees.

ACCORDING to an editorial in the *Electrical Engineer* (Sept. 4) the electrician of the Detroit municipal lighting commission has officially denounced shade-trees as a "nuisance." "They not only shut out the electric light, but God's own sunshine." "Their stems are stubby, and their foliage is a clumpy sponge." "It is difficult to get wires or lamp-posts under them, but the illumination from towers cannot penetrate downwards through their black masses of summer foliage, while in winter their bare arms are constantly breaking and falling upon the streets, the houses," —and last and worst of all—"upon the circuits." As if this were not quite enough, the editorial writer adds, as a result of his own observations, that "they harbor noisy sparrows and hairy caterpillars that are always dropping down one's back," and hence he agrees with the municipal electrician that "the shade-trees need regulating more than the poles and wires do." We must confess to a mild feeling of surprise that our editorial brother admits that the "glorious avenues of Easthampton" are the "pride of every artist." Can a tree with unsymmetrical straggling branches irregularly dotted with chestnut burrs and other like excrescences bear a moment's comparison, from an artistic point of view, with an electric-light pole, with its equidistant and parallel cross-arms and its vivid green-glass insulators in serried rows glistening in the sunlight? Does not every scientific mathematician regard the catenaries in which ropy-looking wires of various shades of white, gray, and black are festooned from pole to pole as examples of the most beautiful curves in nature? And, pray, when did nature ever produce anything in the way of a parasitical fungus which could bear a moment's comparison with a Thomson-Houston transformer? The shade-tree must go! There are no shade-trees in Timbuctoo, and yet we prate of our advanced civilization.

Electric Railway Problems.

THE New Orleans *Times-Democrat* of recent date contains a very interesting discussion of the above subject by Oscar T. Crosby, a well-known authority in electric transportation matters, the substance of which may be found in the *Electrical Engineer* (July 17). Mr. Crosby's views as to the introduction of electricity in place of steam in heavy railway service do not differ materially from those expressed by Mr. Sprague in a recent paper published in this magazine; that is to say, he thinks that the real question as to the advantageous use of steam or electricity on any given line is practically solely one of frequency of service. He expresses the opinion that the existing railway service between New York, Philadelphia, and New Haven, and on the New York Central as far out as Yonkers, might even now be performed by electricity at a cost slightly less than by steam. For rapid transit service he believes that there is no longer any question of the superiority of electricity, not alone on the score of economy, but on those of increased cleanliness and diminished noise. "For all classes of service," says Mr. Crosby, "electric locomotives offer one advantage over steam which the world will more and more learn to appreciate,—that is, very high speed. . . . All well-informed experts are agreed that nothing save the inertia of capital now lies between civilization and a transport speed of 150 miles an hour. It is probable that the earliest line on which such high speeds will be regularly adopted will be that between New York and Philadelphia."

Self-Propelling Road Vehicles.

THE *Electrical Engineer* (July 24) gives some particulars in reference to the recent competitive trial of self-propelling road carriages between Paris and Bordeaux, with illustrations of some of the vehicles and a graphic chart showing the different

runs. The results of this trial make it clear that for this class of work electricity must hereafter be regarded as out of the race. To produce 1 h. p. for 1 hour requires only 0.88 lb. of gasoline, while at least 6.6 lbs. of coal, or 220 lbs. of storage battery, are necessary to do the same work. In its editorial comments on the results of the competition the *Electrical Engineer* hazards the observation that "the conclusion is unavoidable that for long distances, such as those covered by the Paris-Bordeaux contest, the electric storage-battery carriage is not yet available." But for shorter distances, in which "comfort is the first consideration," the writer has no hesitation in saying that the comparison between the storage battery and motor and a heat-engine of any kind is almost ludicrous. "Far, therefore, from losing courage," says this writer, "those who are devoting their attention to the construction of electric carriages should redouble their efforts." We cannot concur in this advice, however well-meant it may be. The *ignis-fatuus* of storage-battery traction marks the position of a bottomless sink-hole into which millions of dollars have been poured during the past 15 years, with results which thus far, and as far as the eye of the expert can discern in the future, are not merely discouraging, but absolutely hopeless. With the advent of a system of improved highways, the general use of mechanically-propelled vehicles must almost necessarily follow, but that they will be driven by electric power in any form is most unlikely, and that the source of power will be a storage-battery must be regarded as the wildest of improbabilities.

Electrically-Lighted Channel-Buoys.

THE lighthouse board have recently completed a permanent plant for lighting the main channel leading into the harbor of New York, as a result of experimental work commenced some time since, and which has proved in most respects very satisfactory. The *Electrical Engineer* (July 31) contains an illustrated description of the plant and a map showing the location of the lights on each side along the channel. The generating station is on Sandy hook, and sends an alternating current of 1000 volts through a submarine cable having a total length of 32,660 ft. The buoy lamps are incandescents of 100 c. p. enclosed in glass globes, and are fed by small transformers in water-tight cases, which reduce the potential at the lamp terminals to 100 volts. The effect of the brilliantly-lighted water-lane, when seen from the deck of a transatlantic steamer, is a novel and attractive one, while its practical value is so apparent that it need not be enlarged upon. The whole work has been intelligently designed and well-executed, and may be said to mark a distinct advance in electrical engineering.

The Storage Battery as a Motive Power.

WE still hear of renewed attempts to introduce the storage battery as a motive-power for street-cars. It seems as if investors might learn, after a while, to throw no more good money into such a bottomless sink-hole.

One of the most persistent attempts to work cars by storage-batteries has been made by the Birmingham (Eng.) Central Tramways Company, and some of the latest results are given in the *Electrician* (Aug. 30). Last year the chairman graphically described the situation as one of "mingled difficulty and hope," a very restrained dose of prophecy for a chairman, seeing that a *bona-fide* profit of over £1200 had actually been earned by the accumulator cars for the first time in history. Unfortunately his successor this year was compelled to chronicle a loss of £1735,—attributable, of course, not to the system of traction, but to bad weather, fire at terminus, and omnibus competition. The figures presented showed that, while the mileage had remained stationary, the receipts had decreased 6 per cent., and the expenses increased 27 per cent., the total cost per car-mile having grown from 14¾d. to nearly 18½d. The exact figures of the cost of the four different systems employed by the company per car mile are as follows: cable, 5.43d.; horse, 8.67d.; steam, 9.11d.; storage batteries, 18.43d. No wonder one of the directors was led to exclaim that "he had come to the conclusion that,

so long as they worked this line by the accumulator system, so long would they have a millstone round their necks which would drag them to the ground."

The *Electrician* says: "It is not considered particularly chivalrous to strike a man when he is down, and, acting up to this laudable tradition, we will not duly enlarge upon this matter. Suffice it to remark that the Birmingham line is not an abnormally trying one, that several types of cell have been employed, and that these experiments on a commercial scale have now lasted several years. And yet there are individuals who affect to believe in electric omnibuses."

Measuring the Velocity of Projectiles.

IN the *Electrical World* (Aug. 10) A. C. Crehore and G. O. Squier describe a series of tests conducted with a new instrument for measuring the velocity of projectiles, made by them at the artillery school at Fortress Monroe last January. The superiority of the particular instrument employed resides in the fact that, in recording the effect of a variable current of electricity, no ponderable matter is required to be moved, as in the case of the instruments heretofore employed for this purpose. As many as ten observations were obtained at regular intervals of 5 ft., beginning at the muzzle of the gun and extending to a distance of 45 ft. From measurements on the photographic negatives it was clearly demonstrated that the velocity of the projectile actually increases after leaving the gun,—a fact which had long been suspected, but never before experimentally demonstrated. The apparatus depends for its action upon a beam of polarized light which registers itself upon a moving photographic plate. The direction of the ray is controlled by a variable magnetic field. Full details of the apparatus and results are given in the paper, which is one of unusual interest.

Induction in House Wiring.

IN a letter to the *Electrical World* (Aug. 10) Mr. W. M. Venable calls attention to the deleterious effects of induction due to running the direct and return wires of an alternating circuit in separate iron tubes, instead of placing both in the same tube, as good practice dictates. He mentions in particular a case of a church building, wired throughout in this way for a 52-volt secondary distribution, in which the inductive drop proved to be so excessive that there was not sufficient potential at the lamp-terminals to enable the voltage to be read on an instrument, and it was actually found necessary to tear out four-fifths of the iron pipe, and insert condensers to overcome the effect of that part of the pipe embedded in the walls which could not be reached without pulling them down. Mr. Venable observes that this method of installation only serves to defeat the very purpose for which iron pipe is employed,—that of making the work fire-proof. If, for instance, a wire becomes grounded in each pipe, wherever the pipes may come in contact an arc is liable to be formed which may easily set fire to the building, whereas, when both wires are in the same pipe, the effects of an accidental short circuit must be confined within it, and, if the pipe has sufficient thickness of metal, no such danger need be apprehended.

Freight Traffic on Electric Railways.

WITH the rapid increase of suburban and inter-urban electric railways, a considerable demand has arisen for facilities for carrying freight, express, and mail matter, and a number of special types of motor-cars have been designed and constructed for this particular service. The *Electrical Engineer* (July 17) gives a *résumé* of the progress which has been made in this direction in different parts of the country with illustrations of some of the vehicles used. Apparently the favorite type for this service is a "combination" car, provided with separate compartments for passengers and freight. In many instances such a car is provided with motors sufficiently powerful to enable it to act as a locomotive and to haul one or more trail-cars. The article gives many interesting particulars of the special features of the equipment of a number of roads in different parts of the country which have under-

taken to carry merchandise as well as passengers. Undoubtedly this can be done in very many instances greatly to the profit of the undertakers, and to the convenience of the general public. Postal-cars are also rapidly being introduced on the street-railway systems of the principal cities, and are found to greatly expedite the collection and delivery of the mails.

Transformer Economy.

THE results of a carefully conducted test of commercial transformers by A. H. Ford of the University of Wisconsin is given in a paper read by D. C. Jackson before the Northwestern Electrical Association, published in the *Western Electrician* (Aug. 24). The table in which the results are summarized shows, as might have been expected, that in most cases the transformers with the smallest iron loss give the highest all-day efficiencies. A comparison of two transformers of leading commercial types, in which the copper loss was substantially the same, showed that one consumed in its operation something like 3 per cent. more current than the other, while, on the other hand, the self-regulating properties of the latter were considerably better than those of the former. The conclusion reached is that the copper losses in transformers of all sizes should never exceed 3½ per cent. at full load, and ought to be kept down to between 1½ and 2½ per cent., while the total drop in potential in the secondary due to full load, if the primary is kept constant, ought not to exceed 3½ per cent. The testing of each individual transformer before being placed in circuit is strongly recommended, and it is shown that this may easily be effected by means of a watt-meter and volt-meter, with which every central station should be supplied.

Modern Power Transmission.

THE London *Electrical Engineer* (Aug. 16) publishes an interview with Mr. C. E. L. Brown of Switzerland, an engineer who planned many of the earliest of the successful power-plants in Europe, which contains some statements of interest. Mr. Brown prefers the single-phase alternating system of distribution in cases in which the principal demand is for lighting and the motor service comparatively unimportant; if the call for power and light is approximately equal, the two-phase is better, while he always adopts the three-phase system in cases in which the power-supply largely predominates. He commends the practice, followed by the Stanley company in this country, of furnishing directly from the generator all potentials up to and including 5000 volts; this pressure is ample for all distances up to 10 miles. For small motors he employs a reducing transformer, although he has constructed one 5000-volt motor of 110 h. p., which has been running successfully for over a year. His estimate of the average cost of hydraulic works including turbines, is from $160 to $200 per h. p. of output; for the generating plant, including switchboard apparatus, $20; for the line, anywhere from $10 to $20 per h. p.; making a total of, say, $220 per h. p. He advises the use, in direct current installations, of multipolar machines in all sizes above 50 k. w. of output.

The Unit Fever.

A VERY lively and entertaining correspondence is going on in the columns of the British technical journals, especially the *Electrician*, anent a new series of units relating to magnetic values which has been proposed by some of the learned gentlemen to whom one correspondent irreverently refers as "the scienticulists of the B. A." The practical dynamo builders do not seem to be impressed with the necessity of introducing so many additional units, although one of them admits that he always thinks of the proposed "thom" as "a unit of squirming in the ether." Another constructor says that engineers have heretofore got on very well without any unit of lines of force, and thinks that it would be no more useful than to coin a new word for "one revolution" and another for one thousand revolutions,—a kilo-revolution, to wit. Still another constructor observes that "conversions of the dimensions in a design from centimeters into inches are a serious nuisance, which

an engineer cannot afford to submit to merely in order to support a theoretical system of measurements." Up to date, it looks as if the "practicians" had rather the best of the argument, so far as magnetic units are concerned.

Electric Traction at the Railway Congress.

THE London *Electrical Review* (Aug. 30), speaking of the report on the general question of electric traction presented to the late International Railway Congress, characterizes it as "deplorably weak," and thinks that it has little to commend it to the serious attention of railway engineers beyond a very ample discussion of the Heilmann locomotive. Much space is devoted to the consideration of such obsolete devices as chain-gear and double-reduction motors, while the recent successful applications of high-tension alternating currents transmitted from a distance and transformed at a sub-station into continuous currents are not so much as mentioned. It would seem, also, as if some detailed account might have been given of such important and interesting applications as those recently made by the Baltimore & Ohio Company and the Chicago elevated railway. However disappointing the report may be, the *Review* nevertheless regards it as a good sign that the subject should have received some attention during the deliberations of the congress, and trusts that another year it will be more fully and practically treated.

Incandescent Street Lights.

REFERENCE was made in these notes last month to a paper by George Cutter advocating the use of the incandescent rather than the arc lamp for street lighting. This paper was followed by an interesting discussion, which is reported in the *Western Electrician* (Aug. 24). One speaker admitted that, if the end in view was to make a display of luxury, arc lamps were, of course, preferable, but that he could supply ten 16-candle incandescents for the price of one arc, and give much better service. In Beaver Dam, Wis., the incandescent lamps are placed so as to illuminate the sidewalks rather than the street; as one speaker said, horses don't need a bright light. Another speaker said that in Racine, Wis., arc lamps of 1200 nominal c. p. had been substituted for the 2000 c. p. arcs formerly used, and that not one of the citizens ever noticed the difference, which leads one to think that they must have always looked at the lamps, and not at the illumination produced in the streets. The general opinion of those participating in the discussion appeared to be that the present tendency in street-lighting is towards the liberal use of incandescent lamps, supplemented in some cases with arc lamps in the business districts, to be used only during business hours in the evening.

The Liverpool Electric Railway.

THE London *Electrical Review* (Aug. 16) contains a report of the operations of the above-named line for the past half year, from which it appears that the enterprise is proving a very successful one. During the 6 weeks which had elapsed since June 30, the number of passengers carried showed an increase of 55,000, and the receipts were £1668 more than those of the corresponding period of last year. The receipts for the half-year averaged 1.92d per passenger. The physical condition of the structure was never better than at present. An extension of the line to the southward had been contracted for, and would be completed within a year, which would undoubtedly bring a large accession of traffic. Dividends were recommended of 2¼ per cent. on ordinary shares and 5 per cent. on preference shares.

Non-Magnetic Electric Devices.

UNDER the above title, Mr. W. E. Irish, in the *Electrical Engineer* describes a large number of typical mechanical devices and movements where the electro-magnet, which has heretofore formed an essential part, has been replaced by an electro-thermal conductor, producing motion by its alternate expansion and contraction during the process of heating and cooling. Mr. Irish lays down the following somewhat startling proposition,—*viz.*, "if it is a fact that a straight wire,

measuring perhaps but a few inches in length and offering comparatively no resistance or counter-electromotive force as compared with an electro-magnet, will give the same result with fewer parts, greater simplicity, and higher economy, then there should be no objection to the relegation of the electro-magnet to the antiquarian's cabinet." He then proceeds to show by diagrams how some twenty or more devices in common use, among which may be mentioned telegraphic instruments, electric bells, telephones, regulators, etc., may be operated in this way. Mr. Irish has certainly cultivated with some advantage a very much neglected field of research, and some of the results he claims to have obtained, if well founded, cannot but prove valuable and important. At all events, the paper is a most suggestive one, and will serve to direct attention to the inviting possibilities of the subject.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Electricity in the American, English and British Colonial Technical Journals—See Introductory.

Lighting.

734. Selection of High-Speed Engines for Electric Lighting. Fred W. Richart (It is the purpose of this article to point out details of design and construction that are desirable and those to be avoided). Elec Wld-Aug. 10. 3400 w.

749. Tests of Incandescent Lamps (Prof. B. F. Thomas' tests of the Packard incandescent lamps, the object of which was to determine candle-power and efficiency at suitable intervals during a period of at least 600 hours). Elec Wld-Aug. 17. 1800 w.

*833. Horizontal Carbon Projectors. Ill. E. A. N. Pochin (Tests of the Crompton automatic and hand-feed lamp, with description). Elect'n-Aug. 9. 1000 w.

893. Buffalo Bill's Portable Electric Light Plants. Ill. Frank B. Widmayer (Descriptive). Elec Eng-Aug. 21. 1000 w.

*924. Refuse Destruction as Applied to Electric Lighting Purposes, (Practicability of.) Ill. E. Manville (Paper read before the Hull Congress of the British Inst. of Public Health). Elec Eng, Lond-Aug. 16. 3500 w.

*958. The Electric Lighting Plant at Victoria Station, L. C. and D. Railway. Ill. W. D. & S. R. (A detailed description of one of the oldest plants in England). Elec, Lond-Aug. 16. 2000 w.

*991. Dust Destructors and Electric Lighting. — Shoreditch (Descriptive). Elec Rev, Lond-Aug. 16. Serial. 1st part. 1500 w.

*992. The Edinburgh Corporation Electricity Works. Ill. (Two distinct and separate systems of supply under one roof). Elec Rev, Lond-Aug. 16. 4000 w.

*993. Interesting Effect Observed With the Voltaic Arc. Albert Nodon in L'Electricien (Due to arrangement of reflector). Elec Rev, Lond-Aug. 16. 1100 w.

*1057. Notes on Experimental Investigations of the Arc. Ill. W. H. Freedman (A short history of procedure which finally resulted in separating by actual physical measurements the counter electromotive force from the resistance). Elec Pow-Sept. 1500 w.

*1059. Electrically Lighted Buoys. Ill. Ira W. Henry (Historical and descriptive). Elec Pow-Sept. 2500 w.

*1289. The Localization of Earth Faults in Electric Light Circuits. J. Pigg (Mathematical with diagram). Elect'n-Aug. 30. 500 w.

Power.

*701. Notes on Hydraulic Power Supply in Towns—Glasgow, Manchester, Buenos Ayres, etc. Edward B. Ellington (General arrangement, boilers, accumulators, mains, efficiency, etc). Elec Eng, Lond-Aug. 2. 4500 w.

*731. Traction by Accumulators. Ill. (Regards success as still doubtful, but thinks recent experiments in Paris give hope that difficulties will be ultimately surmounted. Describes accumulator cars apparently successful in Paris). Elec Rev, Lond-Aug. 2. 1200 w.

*737. Electric Mining Locomotive. Ill. (Descriptive). Ry Wld-Aug. 700 w.

895. Power Plant Economics, J. W. Greer. (Practical and valuable suggestions). St Ry Rev-Aug. 3300 w.

896. Overhead Construction in the Baltimore and Ohio Tunnel. Ill. (Descriptive). St Ry Rev-Aug. 600 w.

*925. Electrical Haulage at Earnock Colliery. Ill. Robert Robertson (Descriptive of colliery generating plant, electrical hauling engines, working, haulage cables, pumping, &c). Ind & Ir-Aug. 16. 2500 w.

*1044. Electric Motor Drives a Cable Plant. Ill. (The first of its kind. Descriptive). St Ry Rev-Aug. 15. 800 w.

1055. Additional Solutions of the Electrolytic Problem. Ill. Arthur V. Abbott (Expedients which have been proposed, affording more or less partial solutions of the problem). W Elec-Aug. 31. 1200 w.

*1060. Calculations of the Weights of Accumulators Required for a Railway. G. Chevet and H. Boy de la Tour (Mathematical). Elec Pow-Sept. 900 w.

We supply copies of these articles. See introductory.

†1087. The Electric Railway of Milan, Italy. Ill. (Plant installed on the Edison system). St Ry Jour-Sept. 1200 w.

1126. Western Avenue Power Station of the North and West Chicago Street Railroad Company. Ill. (Description of plant). Power-Sept. 500 w.

*1148. Electric Railways in Maryland (Maps of electrical railways into and in Baltimore and connection with Pennsylvania lines, with a discussion on their utility). Am Eng & R R Jour-Sept. 2700 w.

*1175. Nikola Tesla and the Electrical Outlook (The new development in power transmission). Rev of Rev-Sept. 1800 w.

*1176. Industrial Niagara. Ill. Arthur Vaughan Abbott (Descriptive, with consideration of possible distance that power can be delivered in competition with steam). Rev of Rev-Sept. 1800 w.

1181. Some Applications of Storage Batteries. Ill. R. Macrae (Description of a few plants where the battery is used for work formerly done by primary cells). Elec Eng-Sept. 4. 2500 w.

1182. Electric Car Tests. Ill. Hermann S. Hering, assisted by Charles Reutlinger and B. Harrison Branch (These tests comprised a determination of the performance of electric cars of various kinds under definite conditions of load, speed, grade, track, etc., with a view to obtaining empirical data for these conditions which would at the same time have a fair degree of accuracy). Elec Ry Gaz-Aug. 31. Serial. 1st part. 2500 w.

1197. Economic Size of Feed Wires for Electric Railways. W. F. C. Hasson (Investigations and results believed to be sufficiently correct and easily applied to any particular case). Elec Wld-Sept. 7. 1000 w.

1198. The Choice of Transformers. D. C. Jackson (Read before the Northwestern Electrical Asso. Results of tests by A. H. Ford, with comparisons and data). Elec Rev-Sept. 4. 1700 w.

*1291. Tests of a Polyphase Motor. D. C. Jackson (Results of tests made on a three phase motor at the Univ. of Wis). Elec Eng, Lond-Aug. 30. 1000 w.

*1292. Light Railways and Tramways. R. H. Dorman (Light railways and tramways as constructed in Ireland). Elec Eng, Lond-Aug. 30. 3700 w.

Telephony and Telegraphy.

*690. Future of the Electric Telegraph. P. B. Delany (The possibility of mechanical transmission). Eng Mag-Oct. 4000 w.

*732. The Official Vocabulary of Code Words. From the London Chamber of Commerce Journal (A record of the steps which the London Chamber of Commerce has taken in the matter, and a summary of the arguments and criticisms which have motived its opposition to the adoption of the official vocabulary in its present form). Elect'n-Aug. 2. 2200 w.

748. The Telephone Monopoly and Subverted Patent Law. E. B. Frost (Argument to combat concession made to the Bell Company, maintaining that such concession is illegal in that it subverts the United States patent law). Elec Wld-Aug. 17. 4200 w.

751. Storage Batteries in Telegraph Work. Ill. (Its superiority, advantages, &c). Elec Eng-Aug. 14. 1300 w.

*882. The London Telephone Service. A. R. Bennett (Record of progress since 1892). Elec Plant-Aug. 1300 w.

889. Sending Pictures by Telegraph. Ill. (Method devised by W. H. Lowd, of Duluth, Minn). Elec Rev-Aug. 21. 800 w.

892. The Sabin-Hampton "Express" Telephone Switchboard System. Ill. (Descriptive). Elec Eng-Aug. 21. 1300 w.

*995. The Telephone in England. G. L. Addenbrooke (Comments on costs and table showing wages paid in continental countries and England). Elect'n-Aug. 16. 700 w.

1018. The Growth of Long Distance Commercial Telephony. Map (Comments and statistics from the last report of President Hudson, of the Am Bell Telephone Co). Elec Eng-Aug. 28. 1800 w.

1021. The American Bell and Western Union Agreement of 1879 (First and full publication of the exact text of the famous compact of 1879, with editorial). Elec Eng-Aug. 28. 13500 w.

1022. Daily Insulation Testing of Telegraph Lines. W. H. Preece (Read before the Institution of Electrical Engineers. Description of method adopted). Elec Rev-Aug. 28. 1300 w.

Miscellany.

733. Measuring the Velocity of Projectiles. Ill. Albert C. Crehore and George O. Squier (Experimental tests of a new instrument). Elec Wld-Aug. 10. 3800 w.

760. The Capacity of Electrolytic Condensers. Samuel Sheldon, H. W. Leitch and A. N. Shaw in the "Physical Review" (Effect of electromotive force on capacity; effect of electrode surface; temperature; coupling of cells, &c). Elec Rev-Aug. 14. 2200 w.

769.—75 cts. A Comparison of the Dissociation Values Calculated from Solubility Experiments and from the Electrical Conductivity. Arthur A. Noyes and Charles G. Abbott (1. Aim and principle of the investigation; 2. Preparation and analysis of the salts; 3. Methods of procedure; 4. The experimental results; 5. Calculation of the dissociation; 6. The validity of the solubility principles; 7. The electrical conductivity of the salts and the values of the dissociation calculated therefrom; 8. The agreement of the dissociation values obtained by the two methods). Tech Quar-April. 3500 w.

*832. Lines of Force. W. G. Rhodes (A determination of the equation of a line of force due to any two poles, irrespective of magnitude and sign). Elect'n-Aug. 9. 700 w.

*836. The Invention of the Electromagnet (Criticism of article by M. Pellissier, by E. Boistel, in Revue d'Electricité). Elec Rev, Lond-Aug. 9. 2400 w.

We supply copies of these articles. See introductory.

*837. On a Low-Resistance "Dry" Accumulator. Desmond G. Fitz Gerald (Notes of experiments in connection with Fitz Gerald's system of working accumulators with an absorbed electrolyte, or converting them into so-called "dry" cells). Elec Rev, Lond–Aug. 9. 1400 w.

*838. The Magnetic Qualities of Forged Steel (Tests made by George O. Squier at the laboratory of the Johns Hopkins University). Elec Rev, Lond–Aug. 9. 1600 w.

*839. On the Use of the Quadrant Electrometer as a Differential Instrument. Riccardo Arno (Abstract from the Rendiconti of the Royal Lyncean Academy). Elec Rev, Lond–Aug. 9. 1000 w.

*848. The Potentiometer and Its Uses. Ill. Ellis H. Crapper (Because of the general application of the instrument in electrical measurements, the attention of students and electrical engineers is drawn to the principles applied, and to the construction and methods of using). Elec Eng, Lond–Aug. 9. Serial. 1st part. 1800 w.

*849. The Behavior of Transformers Under the Influence of Alternating Currents of Various Periodicities (Abstract of paper by Dr. G. Roessler, of Berlin). Elec Eng, Lond-Aug. 9. 1000 w.

912. On an Approximate Law of Magnetic Remanance in Iron and Steel. Edwin J. Houston and A. E. Kennelly (A diagram showing relation between remanance and maximum cyclic intensity). Elec Wld–Aug. 24. 600 w.

913. On the Use of Magnetic Formulæ in Electrical Design, Reginald A. Fessenden (Mathematical). Elec Wld–Aug. 24. 1600 w.

*994. A Graphical Method of Analyzing Harmonic Curves. E. Basil Wedmore. Elect'n–Aug. 16. 500 w.

1010. The Determination of the E. M. F. of Alternators. Ill. R. P. Brousson (The object of this article is to show how the E. M. F. of any alternator running on open circuit can be obtained, when the speed of rotation, the magnetic flux, and the shape and relative dimensions of the armature coils and field poles are known). Elec Wld–Aug 31. 1300 w.

1012. Tests of a Combined Electric Light and Electric Railway Central Station. Ill. Dugald C. Jackson and Arthur W. Richter (The tests described are of refined character and exhaustively include in their scope all parts of the plant). Safety V–Aug. 15. 4500 w.

1019. Researches on the Electric Discharge of the Torpedo. A. d'Arsonval (Abstract of a communication to the French Academy of Sciences. Lighting lamps and Geissler tubes). Elec Eng–Aug. 28. 1100 w.

1020. The Electric Furnace and Chemistry at High Temperature Ill. H. Moissan (What has been accomplished by means of this apparatus, and its operation. Its use in the working of metals). Elec Eng–Aug. 28. 1000 w.

1054. Compounding Dynamos for Armature Reaction with Converters. Ill. (Statement from Dr. W. P. Freeman). W Elec–Aug. 31. 700 w.

*1056. How Shall We Educate Our Sons for the Electrical Profession? Nelson W. Perry (An attempt to outline the general features, not the details, of the education which a young man should strive to attain if he aims to become an electrical engineer). Elec Pow–Sept. 4800 w.

*1058. Alternating Currents. Dr. Louis Bell (Paper read at Cooper Union, in connection with the Columbia College University extension). Elec Rev–Sept. 6000 w.

*1183. Action of the Electric Current on Aluminium Wires. Ill. (This article from La Nature is signed by Ch. Ed. Guillaume, but the first portion appears to be due to Prof. Margot). Elec Rev, Lond–Aug. 23. 1800 w.

*1184. Municipal Electricity. James Perry (Paper read before the Incorporated Asso. of Munic. and Co. Eng. at Londonderry. Its purpose is to assure municipal engineers that this new claimant of attention is in no way dangerous). Elec Eng, Lond–Aug. 23. 4400 w.

*1185. Unipolar Induction. Ill. C. L. Weber (Comments on the subject as treated by Prof. Lecher, with description of some experiments carried out by him). Elec Eng, Lond–Aug. 23. 1500 w.

*1186. Phase Difference in Alternate Current Electrolysis. W. R. Cooper (Experiments described by Herr Peukert with the object of investigating whether such phase difference does exist, with comments and brief reproduction of article by Herr Dolivo-Dobrowolsky). Elect'n–Aug. 23. 1700 w.

*1187. Electric Furnaces and Their Application to the Transformation of Carbon into Graphite. Ill. Ch. Street, with Editorial (Facts concerning early and recent types of electric furnace; review of the attempts that have been made in the direction of applying electricity to metallurgy; and description of methods for transforming carbon into graphite). Paper read before the Société Internationale des Electriciens. Elect'n–Aug. 23. 6500 w.

1274. Means of Preventing Electrolysis of Buried Metal Pipes. Ill. Isaiah H. Farnham, in Cassier's Magazine (The equi-potential return system recommended). Am Gas Lgt Jour–Sept. 9. 2500 w.

*1287. The Tin Chromic Chloride Cell. S. Skinner (Construction of cell. An interesting feature is that it may be used as the mechanism of a heat-engine for the production of work, and the complete cycle of Carnot can be traced in it). Elec Rev, Lond–Aug. 30. 600 w.

*1288. The Self-Induction of Armored Mains. J. Whitcher (A brief statement of the theory of the extra self-induction of conductors, due to iron armorings or surroundings, leading to some useful practical formulæ and approximations). Elect'n–Aug. 30. 2200 w.

*1290. On the Electrolysis of Gases. J. J. Thomson, with Editorial (Paper read before the Royal Society. Experiments and methods. Electrolytic transport of one gas through another. Polarization of the electrodes. Discharge through a compound gas, etc). Elect'n–Aug. 30. 7800 w.

We supply copies of these articles. See introductory.

INDUSTRIAL SOCIOLOGY

The Relations of Employers and Employed.

A GOOD contribution to current literature upon this subject is contained in an article written by Mr. Earnest H. Johnson and printed in *The Railroad Gazette* (Aug. 23). Mr. Johnson is connected with the management of the New York, Lake Erie, and Western Railway, and the methods of the management of that corporation in dealing with its employees are the burden of his paper.

First, as to selection of employees: the corporation is stated to be governed in this matter "largely by the law of supply and demand; but, while this must always be the paramount consideration," Mr. Johnson thinks inquiry ought also to be made into past records of a man seeking employment, particularly if "the applicant has before been employed as a railroad man." As it is, "under the present system of taking men as they come and are needed, there is fostered a class of floaters (refuse generally from other remote systems), who are bad for the morale of the regular men and a source of expense and danger. A printed form of application should be used, covering all necessary qualifications as regards employment. Two stipulations are specially important: first, that the applicant shall be no more than 45 years of age, and, second, that he shall be able to read and write."

On the road in question, we are told, there are two schools for training new men,—a "train rule school" and "an air-brake school." But this is not thought sufficient. It is suggested that, in addition, the qualifications of railway employees should comprise at least such a knowledge of reading, writing, and arithmetic as would pass them through a primary department of a public school, though this suggestion is not made the basis of any recommendation as to the means of imparting such knowledge to railway men found to be deficient in it, other than that some facilities be afforded them for supplying the deficiencies.

The system of promotion which prevails on the railroad above named, in which "seniority is the governing factor," is criticised as being "absolutely pernicious." The criticism is justified as follows:

"No two men possess in equal proportion those qualities of energy, push, activity, good judgment, and general intelligence, the greatest combination of which in the greatest number is absolutely essential to best results; and such a rule is absolutely untenable. It dwarfs ambition and individuality. By the very preponderance of mediocrity it leavens the whole lump, leveling down to that plane of second-rate abilities which any scheme based entirely on the mere longevity of the men is bound to foster. Such a system, moreover, fosters discontent and desire for change in young men of ability and energy, who feel that, however they do their work, their future depends almost wholly on the death-rate among their less active and energetic seniors. A system based on the service record of the men, coupled with recognition of exceptional evidence of good judgment and active energy in cases of emergency, would give much better results."

Supervision and discipline are administered on this road by the "train master, assistant train master, and yard master, and indirectly by the superintendent." The spirit in which the performance of these functions is enjoined, as set forth in the following quotation, is admirable.

"One of the first essentials for an ideal service is a willing one. For a willing service it is absolutely necessary, first, that the men shall respect a superior, and, second, that they shall have a personal liking for him. Respect can be engendered in no more effective way than by the evidence, on the part of an officer, of a perfect and comprehensive knowledge of the work done under and for him. And also by the

enforcement (even to severity if need be), absolutely impartially, of punishments for infractions of or derelictions in duty. Nothing is more telling than a little of that fellow-feeling which makes us all kin. A courteous habit of at least listening to the real or fancied grievances of the men soon begets in their minds the conviction that, if a thing is worth having, it is worth asking for. And if these requests, when judiciously possible, are granted, a feeling of trust and confidence in the officer is fostered. Another potent promoter of zeal is a kindly forethought for the comfort of the men when exposed at wrecks. The writer has in mind a very forcible object lesson, where twenty men with 'full bellies' were worth forty half-fed and dispirited men.

"Punishment should be reduced to a minimum, and the past record of the offender taken into consideration. To do this with anything like completeness, a debit and credit system would have to be established. Minimize the publicity to disciplined employees, as it will largely do away with the humiliation arising therefrom. Never discharge a man where there seems a possibility for reform, but, once having discharged him, particularly for lying, continued drunkenness, and general unreliability, never re-employ him."

The system of premiums for service is spoken of as of doubtful utility. It apparently works well in some instances, and in others is a source of jealousy and disaffection. Probably the chief difficulty to be encountered is to secure impartial awards. On the Erie road there is a system of relief in cases of disability resulting from injuries received in the performance of duty; further than this there is no systematic provision for sickness, for superannuation, or for pensions. Mr. Johnson evidently regards such provisions with favor, notwithstanding current objections, and speaks commendingly of their institution and operation in Europe.

The Erie road has provided liberally for the comfort of its employees at terminals, by the establishment of libraries, reading-rooms, baths, and sleeping accommodations. The establishment of schools for technical training is also suggested as desirable.

Municipal Progress and the Living Wage.

WHY should not the adjustment of wages through free competition be permitted in the execution of municipal work? On what just principle can wages for municipal labor be fixed by law, that does not apply equally to all other labor? Ought not sound business methods to be adopted in the conduct of city affairs as much as in private affairs, or in the conduct of large industries? These questions, though not formulated in the above language, are, by implication, asked and in substance answered by D. McG. Means in *The Forum* for September.

The article begins with a reference to the experience of the past year in the department of street-cleaning in New York city under Colonel Waring's able administration, as "illustrating in the clearest way in which the illustration has yet been given the grave danger that besets the path of municipal government in the future." This illustration is both pertinent and peculiar. "When Colonel Waring took charge of the department of street-cleaning, he found that he was required by law to pay in wages nearly double what was necessary. He demonstrated that he could clean the streets properly for the amount appropriated, provided he could obtain authority to pay the rate of wages current in the market, and that he could give the laborers so employed steady work; or he could clean the streets imperfectly, paying the wages fixed by law, and giving somewhat irregular employment. But, if the city wished to have the streets kept clean at all times, while he was obliged to pay the legal wages, it would be necessary to have a much larger appropriation. The issue was most explicitly stated by Colonel Waring, and most carefully evaded by the city authorities. Violent attacks were made on him from various quarters, and at one time the press seemed about to abandon his cause. But the admirable condition of the streets was a weightier argument in his favor than any that could be brought

against him, and at the last moment the city authorities yielded.

"But they did not yield on the matter of wages. They tried to see if expenses could not be reduced in every other direction, but the plain course suggested by Colonel Waring they most studiously ignored. And they were finally driven to strain the law in a manner which was shown by one of their own number to constitute a most dangerous precedent. The board of health is empowered, when sudden emergencies arise, such as the advent of pestilence, to call for appropriations of exceptional sums of money. It was pretended that, unless the system adopted by Colonel Waring was kept up in full perfection, the health of the city would be suddenly and seriously endangered, and by the aid of this transparent fiction an appropriation largely in excess of that provided by law was made available."

The reason for this attitude of the city authorities can be logically inferred from the reason why wages were fixed by law in the first place. The scheme was to make the taxable property-owners in the city not merely pay the expenses of the legitimate execution of necessary public works, but also contribute to the support of the political "machine." The assessment of the office-holders was "the most convenient way of raising political funds," and, "in order that they might pay these assessments without resistance, the legislature was induced to fix their compensation at a rate higher than the market rate, thus leaving a substantial margin for political contributions. It is easy to see why men who have been engaged in politics in New York should be unwilling to disturb this system or publicly to recognize its existence. But it is not so easy to understand why reformers have not attacked it, or why the public appears to be indifferent to it. But it seems probable that a doctrine known in England as that of the 'living wage' has exerted a silent, but powerful, influence in checking any movement to cut down the wages paid by the city of New York to its servants."

The principle of the so-called "living wage" is then set forth as demanding "that workmen should get more than what their labor will bring in the market." In other words, "they should be paid, not what they will consent to receive, 'pinched by hunger and under the stress of need,' but such wages as will enable them to maintain a proper standard of living. There is a 'moral minimum' of earnings below which they ought not to sink, and employers of labor should observe this principle in dealing with their workmen. But as the ordinary employer is prone 'to do business on business principles,' municipal bodies have been selected by the English Socialists as proper agencies for establishing this 'moral minimum,' and it is said that over two hundred and fifty local governing boards in England—to say nothing of the general government—have now adopted the principle."

The benevolent motive inducing this action in England is not denied; on the contrary, it is positively affirmed. An inquiry as to how far this action has or can secure "an improved standard of living among the poor" is next submitted to reason, and it is shown that whatever increase of wages is thus apparently brought about is the result of subtraction from the wages of those who do not share the favor, as taxation is borne inevitably by the consumer, and the increase of pay to municipal workers is only possible by increase of tax rate. The only possible way to prevent this is by taxing "the luxurious consumption of their employers. If their employers will deny themselves some of their accustomed luxuries, the government can indulge its employees in the luxury of the 'living wage' without calling upon laborers as a class to pay for it." Otherwise the whole class must pay for the privilege granted to the few.

This reasoning seems entirely unanswerable. Without following this able argument in detail to the end, we may say that its author is, in our opinion, able to show clearly that the system is open to serious abuse and public danger; that its effect upon general industry is mischievous; and that safety and economy are to be found only in the application of the same business principles to public business that

have been proved by experience to be sound and safe in private affairs.

No Legal Right to Air.

A UNIQUE lawsuit was recently tried in an English court, and, the case having been carried to the court of appeal, the decision of that court has now become a precedent in English law. The issue in the case was the right of enjoining a property owner from erecting buildings on his own land that would interfere with the supply of air to an adjoining building or buildings. The lower court granted a perpetual injunction restraining defendant from so building as to interfere with the supply of air to the adjoining house of the plaintiff. The higher court reversed this decision, so that it now appears that a person might purchase the land surrounding another man's lot, and, so long as he left the latter person access to and from his estate, —a right established by common law,— might build, if he wished to do so, entirely around the inclosed house a building forty stories high, and the owner of the circumscribed dwelling would have no recourse at law, though his holding might thus be rendered practically worthless.

In commenting upon this case, *The Journal of Gas Lighting* (Aug. 23) says no such decision as that which the court of appeals reversed "had ever been given in a court of law in a matter of the kind; and the judge's declaration that the plaintiff had a right to the passage of air coming over the defendant's property was such an important extension of the law relating to light that it is satisfactory to know that the matter was not allowed to rest as he left it." Of course any check upon useless litigation is to be approved, and from this point of view the *Gas Light Journal*, inclined to be liberal in its editorials upon social subjects, approves the action of the higher court. We are not prepared to say that this decision is not good English law; but, if so, it is another instance of the right of the large property holder to disregard the necessities of the small holder. Our contemporary assigns as a further reason for its approval that, if the interpretation of the law by the lower court be sound, enormous difficulties would be put in the way of a freeholder who might have occasion to erect a lofty structure, such as a gas-holder, upon his own land. We quote below the abstract of the decision as given in the article under review. It appears that, while, under English law, the plaintiff had some rights, he had not the right to restrain anybody else from divesting him of those rights,—a state of things that recalls the definition some one gave of Calvinism:

> You can and you can't;
> You will and you won't;
> You'll be damned if you do,
> And be damned if you don't.

"It had been argued that the defendant's new buildings interfered with the natural ventilation of the adjoining premises, and this was not denied; but Lord Justice Lopes, for himself and Lord Justice Lindley, laid it down that, while every man has a natural right to enjoy fresh and pure air, so that whoever send noxious vapors or foul air into his neighbor's premises ought to be restrained, the court could not impose upon his neighbor the obligation to keep away noxious smells. It was contended that, irrespective of any nuisance, the plaintiffs had a right to the free passage of air over and above their premises, and to have every disagreeable smell carried away by the current of air that would pass over the premises. It was held, however, that, inasmuch as there was nothing to prevent the defendant from building on his own land, such a right as was sought to be set up could not be supported, and that a man is not bound to see that his neighbor has proper ventilation. Lord Justice Lindley further remarked, in view of the importance of the case, that no one has a right to complain of his neighbor for building on his own land, even though it might diminish the flow of air on the land adjoining, unless there was an immemorial right to the user, or an agreement binding the owner not to build." The *Journal of Gas Lighting* thinks it a matter of congratulation "that what might have proved a source of vexatious lawsuits has happily been removed." . . . "The law of 'ancient lights' is troublesome enough on

occasions; but a right to ancient natural ventilation would have lent itself to intolerable abuse."

Liability of Employers for Injuries to Workmen.

IN "The Programme of Social Reform" (*Nineteenth Century*, July) Sir John Gorst, M. P., takes a position that appears, rightly or wrongly, to be gaining in popularity. We say rightly or wrongly, because there is another side to the argument than that presented by Mr. Gorst. We shall not attempt the presentation of that other side, our business being for the present with the argument of Mr. Gorst. On the question of employers' liability—one of a number of social questions dealt with by the author—he decidedly takes the ground that employers should be held liable for compensation for injuries received by laborers in service, and he appears to do this with only the one reservation of cases wherein accidents are the results of the workmen's own fault.

After an eloquent portrayal of the condition of the family of a laborer whose main support is rendered by accident no longer a support, but a positive burden, and after a statement that accident insurance only partially meets the real necessities of the case, he asserts that it is desirable that "the burden from which the community at large cannot shake itself free should be fairly and evenly adjusted. In a few cases the loss falls upon the Friendly Society of which the victim is a member; oftener upon the benevolence or sense of justice of the employer in whose service he has suffered; in many cases upon the savings of his family or friends, which the poor apply with such touching generosity to each other's necessities; sometimes upon public or private charity; and, in the last, which is frequently the only, resort, upon the ratepayers, in the shape of the relief of the infirmary and workhouse.

"Justly this inevitable destruction of life and limb in the processes of modern trade and manufacture is part of the costs of rendering the service, or of producing the article, and should be reckoned and paid for as such. It is just as much a matter to be taken into account in determining price as the consumption of material or the destruction of instruments of production.

"The most convenient and effective arrangement for society to make is to cast, in the first instance, the responsibility upon the capitalist of providing the neccessary compensation to the workers and their families, and to leave him to recoup himself by an adjustment, of which the amount would be infinitesimal, of wages, profits, or prices, as the condition of his particular industry may require. The injured worker would thus look to his employer for the indemnity which in a clumsy and unequal fashion society now allots to him; and, if neither wages or profits will bear the minute reduction which the extra cost would entail, some trifling increase of price will have to be paid, as it ought to be, by the consumer for the service rendered or for the article purchased. So far as we can judge from the statistics of foreign countries,—we have no reliable statistics of our own,—about one-fourth only of the accidents which occur in the processes of modern industry are attributable to negligence. A measure like that proposed by the English government 2 years ago, the effect of which was to make the employer liable merely in those cases in which negligence on the part of his servants could be proved, is a wholly inadequate remedy. Everybody who has had any experience of courts knows the difficulty, the expense, and the uncertainty of proving negligence, even where there is not the slightest moral doubt of its existence. But, even if proof were in every case certain, the workers, as to three-fourths of the accidents to which they are exposed, would be no better off than they are now."

The scheme advocated is to have a legalized scale of compensation for various degrees of injury and disablement according to the rate of wages received. This is put forward as being a much more convenient, accurate, and rapid way of arriving at the sums that should be paid for injuries than "the fluctuating caprices of judges and juries." The weak point in

the scheme is the fact that it merely shifts the ground of dispute from the question of the amount that should be paid to the question of the degree of injury received. Given a certain degree of injury, a fixed amount shall be awarded; but who shall determine the degree in cases of dispute? Obviously we do not escape the caprices of judges and juries by thus shifting the ground of inquiry. The fact that an English lawmaker advocates this sort of legislation in one of the foremost English magazines does not exempt the scheme from just criticism. Nevertheless, the tendency to emphasize and render more certain employers' liabilities for accidents to workmen is visible in current Socialistic literature, and Mr. Gorst's scheme is one of the signs of this tendency.

Misdirected Effort.

On "Empiricisms in Politics," by Mr. T. Mackay in *The National Review*, is an able argument against misdirected effort on behalf of the working classes. The effort to induce the state to do something which will improve the condition of working people is the misdirection referred to. The abolition of poverty he thinks must be delayed till another step is taken which he calls "dispauperization." He evidently means to imply that pauperism is a deeper depth than poverty. He speaks for himself:

"It would be easy to name other spheres of action where there is need of intelligent, disinterested and unremitting labor. Dispauperization means the restoration of independence, not the abolition of poverty; that is the next step. The whole question of working-class investment is full of problems of the highest importance. Most pressing, perhaps, among these is the organization of a cheap system of credit. In England the useful institution of co-operative banks is in its first infancy. Yet as Mr. Wolff has clearly shown us from the example of other countries, it is an instrument most potent and beneficent in helping to spread the advantages of property over an ever-widening area. Again there is room for endless experiment and for the exercise of the highest constructive ability in devising terms of industrial peace between labor and capital which will satisfy the legitimate claims of both."

THE ENGINEERING INDEX—1895.

Current Leading Articles on Industrial Sociology in the American, English and British Colonial Technical Journals—See Introductory.

*688. The Revolt in Cuba. Its Causes and Effects. Amilio M. Amores (As related to the United States). Eng Mag–Oct. 3000 w.

†761. The Government and the Bond Syndicate. Brayton Ives (An authentic account of the operations of the Government bond syndicate). Rhodes' Jour of Banking–Aug. 5000 w.

†767. New British Markets. I. Western China. Holt S. Hallett. II. Tibet. C. E. D. Black. Nineteenth Cent–Aug. 14000 w.

*772. A New Suggestion in Economics (The abolition of the right of inheritance. A review of Nordau's new book. Conventional lies of civilization). Jour Gas Lgt–Aug. 6. 1200 w.

†784. Boer, Africander, and Briton in the Transvaal. F. J. Ricarde-Seaver (A study of South African peoples, their social organizations, race prejudices, and relations growing out of racial differences). Fortnightly Rev–Aug. Serial. 1st part. 6000 w.

*812. Limited Liability (Editorial. Points out defects in present English limited liability law, and reviews report of a committee of the Board of Trade, which from a practical point of view, contains less guidance than was hoped for). Engng–Aug. 9. 2500 w.

*842. Profit. By a Keen Observer (What is profit? When do we begin to make it?). Irm–Aug. 10. 1100 w.

886. Common Sense on the Silver Question. O. D. Ashley, in the Independent (How the value of the metals has been established; result of the free coinage of silver, etc). Ry Rev–Aug. 17. 4000 w.

904. The Labor Movement (Its rise, progress and achievements). Mach Mold's Jour–Aug. Serial. 1st part. 3700 w.

916. The Relation of Railroads and Their Officials to Employees. Ernest H. Johnson (Practice on the New York, Lake Erie and Western. Selection of employees; training and advancement; supervision and discipline; premiums; insurance, etc). R R Gaz–Aug. 23. 2000 w.

*937. No Legal Right to Air (Unique decision of the English Court of Appeal). Jour Gas Lgt–Aug. 13. 400 w.

*938. The Enforcement of Law. Theodore Roosevelt (A terse, vigorous, and caustic reply to the criticisms which have been made upon the Police Department of New York City, for its honest enforcement of the existing liquor law). Forum–Sept. 4000 w.

We supply copies of these articles. See introductory.

*939. Municipal Progress and the Living Wage. D. McG. Means (An able argument against the establishment by law, of rates of wages for municipal work, illustrated by the experience of the Department of Street Cleaning of the City of New York under its present administration. The ground is taken that wages for municipal work ought to compete with wages for other similar work). Forum-Sept. 5300 w.

*940. The Benefits of Hard Times. Edward Atkinson (This article points out distinct benefits which have accrued to the railroad manufacturing and agricultural interests as the result of various periods of panic and business reverses, notably the panic of 1893, and the following period of depression). Forum-Sept. 5400 w.

1046. Manual and Sense Training the Great Problem in Education. Peter T. Austin (A lecture given before the Bridgeport (Conn.) Scientific School. Manual training as an element of success). Sci Am Sup-Aug. 31. 8500 w.

†1061. Trend of National Progress. Robert H. Thurston (A scientific prophecy of the near and remote future of the country). N Amer Rev-Sept. 3800 w.

†1062. Crop Conditions and Prospects. Henry Farquhar (A brief history of the progress of the season with a few of our leading farm products). N Amer Rev-Sept. 3800 w.

†1063. The African Problem. Edward W. Blyden (The author's view of the problem in Africa and America). N Amer Rev-Sept. 5800 w.

†1064. Our Reviving Business. James H. Eckels (Review of lessons learned from recent experience and favorable outlook for the future). N Amer Rev-Sept. 2500 w.

1065.—$1. The Income Tax Decisions as an Object Lesson in Constitutional Construction. Christopher G. Tiedeman. An Am Acad-Sept. 4000 w.

*1066. Evolution of Modern Capitalism. (Review of book by John A. Hobson—"A Study of Machine Production"). Soc Ec-Sept. 2000 w.

*1067. Are Export Bounties Economic? (Editorially answers this question, propounded by a professor in Stamford University, emphatically in the negative, and makes a severe criticism on the so-called "Lubin" plan). Soc Ec-Sept. 1200 w.

*1068. Trusts and Wages. Frederick H. Cooke (The author endeavors to show that the existence of trusts tends to increase wages, as well as to prevent and cure industrial depression). Soc Ec-Sept. 1600 w.

*1069. Outlines of an Effective System of Ship Protection. William W. Bates (A department of commerce; protective measures; discriminating duties; bonding privileges; free and reciprocity goods, etc). Soc Ec-Sept. 3200 w.

*1070. The New English Factory Act (A summary of the chief provisions of this act, which comes into operation Jan. 1, 1896). Soc Ec-Sept. 1500 w.

*1071. National Struggle for Existence. Arthur Burnham Woodford. Soc Ec-Sept. 4000 w.

*1135. Wages and Hours of Labor in Transport Industries (Abstract of the Board of Trade (London) Report). Trans-Aug. 23. 2200 w.

*1165. The Commercial Clauses of the China-Japanese Treaty of April 17, 1895 (Taken from French sources, which have been compared with and revised by the official publications issued by the Japanese Government). Bd of Tr Jour, Eng-Aug. 2700 w.

*1168. Tariff Changes and Customs Regulations (Russia, Belgium & Norway, France, Switzerland, Portugal, Spain, Greece, Java, United States, Costa Rica, Guatemala, Brazil, Peru, Venezuela, Cyprus, British India, British Guiana). Bd of Tr Jour-Aug. 6000 w.

*1169. The Problem of the City. Thomas E. Will (How to abolish or mitigate the poverty of the slums, &c., is the unsolved problem). Am Mag of Civ-Sept. 5000 w.

*1170. A Standard of Value. Ellen Battelle Dietrick (Criticism of views of Arthur Kittson). Am Mag of Civ-Sept. 4000 w.

*1171. The New Factor in the Problem of Government. James A. Collins (The tendency toward combination). Am Mag of Civ-Sept. 3500 w.

*1172. The Abolition of Poverty. Whidden Graham (The author considers the cause of poverty to be lack of work due to the monopoly of land, and suggests remedy). Am Mag of Civ-Sept. 3300 w.

*1173. About Production. E. P. Powell (The consideration of how much gain may be hoped from nationalism in the matter of an equitable distribution of the burdens of society). Am Mag of Civ-Sept. 3500 w.

*1174. The Adopted Home of the Hun: A Social Study in Pennsylvania. William Futhey Gibbons. Am Mag of Civ-Sept. 3600 w.

*1179. From the Great Lakes to the Sea. E. V. Smalley (The purpose of the meeting of the International Deep Waterways Association, with account of the organization; the commerce of the mid-continental waterway; the present situation; discussion of the question of prolonging the waterway of the great lakes to the Atlantic coast). Rev of Rev-Sept. 3000 w.

*1189. Trade Unions (Review of the report of the Chief Labor Correspondent to the Board of Trade). Ir & St Tr Jour-Aug. 24. 700 w.

1214. The Relation of Engineering to Economics. William Kent (Extracts from address before the Mechanical Section of the Am. Asso. for Advancement of Science. Effect of improved machinery and methods). Eng News-Sept. 5. 2800 w.

†1222. A French View of British Industry (Claiming that British industrial success is due to not making mere machines of their students). Ind & East Eng-Aug. 3. 800 w.

*1225. Evolution in Banking (Result of the Conference of Australian Bankers). Aust Min Stand-July 20. 700 w.

We supply copies of these articles. See introductory.

MARINE ENGINEERING

Bessemer Steel in Shipbuilding.

THE *Engineering Review* prints an interesting article written by Sir Henry Bessemer which portrays the difficulties that always attend the introduction of a new invention, even the most meritorious. The prejudices of the conservative and the ignorant; the misrepresentations of those whose vested interests are threatened; the fears of the timorous, even after their reason is convinced; wilful misuse by the malicious, who thus seek to prevent or retard the introduction of what they know to be an improvement,—these, together with the normal mechanical, chemical, and physical obstacles that must be met and surmounted, have often discouraged men whose resolution and purpose were strong, but who could not endure the protracted struggle. An abstract of Sir Henry Bessemer's article will show some of the difficulties he had to encounter in getting his steel used for naval construction.

"From the first introduction of my process for the manufacture of steel, I took a deep interest in the application of that material to the construction of ships. My process was published to the world in 1856, and the next few years were necessarily largely occupied with negotiation and development. But so early as 1863 the Sheffield firm with which I was then connected supplied bessemer steel plates for the construction of two stern-wheel barges, the frames having been made of iron. A considerable number of ships were afterwards constructed of bessemer steel, manufactured by Messrs. Henry Bessemer & Co. of Sheffield. They varied from tug-boats of less than 100 tons to a steamer of as much as 1283 tons, the latter having been built as early as the year 1864. In this latter year, indeed, there were no fewer than ten vessels constructed of bessemer steel, aggregating about 7000 tons. The year 1865 also witnessed considerable activity in the same direction.

"Then we come to the first Landore-Siemens steel ship, the twin-screw steamer Storm Cock, 466 tons, built in 1878. Then follow thirteen more bessemer steel ships, the list, however, not showing the tonnage or date. Probably all were prior to 1880, making a total of thirty-four bessemer steel ships built up to that year. I not only took a deep personal interest in this subject, but I invested £10,000 of my own money in order that a shipbuilding firm at that time might develop the use of steel for that purpose. This was in 1864, while the Clytemnestra, of 1251 tons, was being built in Liverpool.

"Although we had constructed no less than eighteen bessemer steel vessels in England previous to the end of the year 1865, it was not until 10 years later that Sir Nathaniel Barnaby, then chief constructor to the admiralty, appeared to wake up to the desirability of employing steel for the construction of ships of war in this country. The fact that the French government was building two large ironclads—the Tempête and the Temeraire—at Brest and L'Ouest seems to have rendered it necessary that the admiralty should offer some explanation as to why they were so much behind the times. Hence, in the paper which Sir N. Barnaby read before the meeting of the Institute of Naval Architects in 1875, he spoke of the devices which the French shipbuilders had adopted for 'coaxing and humoring this material.' He then proceeded to state that 'the points of the greatest interest were those connected with the mode of working the material,' and declared that 'the use of iron hammers in putting it into form was scrupulously avoided.' This makes one wonder whether copper hammers have ever been heard of in connection with the building of iron or steel vessels, and how it was that years

before we had managed to construct eighteen vessels of bessemer steel that were deemed suitable for classification at Lloyd's.

"In the same paper Sir Nathaniel declared that the uncertainties and treacheries of bessemer steel in the form of ship and boiler plates are such that it requires all the care that is bestowed upon it at L'Orient to avoid failure. The question we have put to the steel makers is: 'What are the prospects of obtaining a material which we can use without fear and trembling?' And, to illustrate this 'treacherous' material, Sir Nathaniel held up to the meeting a piece of steel plate, about 15 in. by 10 in., bent in the form of a partly-opened book, showing a crack along the central ridge, which did not extend quite through the plate. It required a bold man to show a piece of thin bessemer boiler plate, bent at an angle of about 15°, cracked partly through from end to end, as an example of the steel that they have to treat and tinker up with copper hammers if they ventured to use it."

This illustrates how men of high position will stoop to misrepresentation for selfish ends. Sir Henry Bessemer, commenting upon Sir Nathaniel Barnaby's statement, says: "I do not hesitate to say that, if steel were ever made that would crack with a fair bending at that extremely small angle, such metal could never have been rolled and sheared without the shearings crumbling away in little pieces, and showing to the plate manufacturer that it was little better than cast iron. In all my experience I only know of one way in which a steel plate, no matter what its quality, could possibly be made to crack partly through, and that way is to have it continuously bent backwards and forwards so that the outer surfaces on the bending line would be alternately crushed together and stretched, until the surface metal opens, while the central part is less affected and holds the plate together. If this was done, I need hardly add that the metal was not subjected to a fair test, and ought never to have been exhibited as a failure in bending at a slight angle. That bessemer steel was not what it was represented to be may be evidenced by the fact that at this very time the London and North-western Railway Company had over three hundred locomotive boilers manufactured of that material, with all the specially difficult flanging of the fireboxes accomplished with steel hammers and without a single failure."

Lights on the Ocean.

THE *Marine Engineer* prints a summary of interesting and valuable information relating to color and visibility of lights at sea, published by the American naval hydrographic office as a result of investigations undertaken by the governments of the United States, Germany, and the Netherlands. A marine observatory in Germany in this connection tested some three thousand running lights actually in use on board ship, and found that two-thirds of them failed to meet conditions prescribed by the international maritime conference held in Washington in 1889. It was then stipulated that the word "visible" should mean visible on a dark night with a clear atmosphere. The Germans have further pursued the inquiry by a systematic series of experiments. A light was set up on shore, and observers embarked on board a steamer which ran over a well-buoyed course. The point at which the light ceased to be visible was noted by each observer independently, as well as the point at which it first appeared on the return trip. The mean of the several observations was taken as the limit of visibility of the light under observation. The naval hydrographic office sends out the following:

"The American experiments undertaken at Long Beach light station gave the following results in very clear weather: a light of 1 c. p. was plainly visible at 1 nautical mile, and one of 3 c. p. at 2 miles. A 10-c. p. light was visible with a binocular at 4 miles; one of 29 candles could be seen faintly at 5; and one of 33 candles was seen without difficulty at the same distance. On a second evening, exceptionally clear, a white light of 3.2 c. p. could readily be distinguished at 3, one of 5.6 at 4, and one of 17.2 at 5 miles. The governmental exper-

iments conducted at Amsterdam gave the following results: a light of 1 c. p. was visible at 1 nautical mile, one of 3.5 c. p. at 2, and a light of 16 c. p. at 5 miles distance. The German observations represent more varied conditions, and a larger number of experiments with lights of widely-differing character and intensity.

"In experimenting with colored lights, it is only necessary to use the green, as it has been conclusively proved that, if a light of that color fulfils the required tests, a red one of the same intensity will more than do so. Comparisons of the observed and computed values of the visibilities of green lights disclose the fact that the calculated are smaller than the observed values for short distances, and greater for longer ones; in other words, the green rays are subject to greater absorption by the atmosphere, even when perfectly clear, than rays of white light.

"Hence it is that, instead of being proportional to the square root of candle power, as is the case with white lights, the intensity of green lights is proportional to the cube root of the same, and the factor for multiplying this quantity is, as determined by the German experiments, 0.80 the distance in miles at which a green light or a single candle power is just visible.

"From this rule the candle power required for a green light to be visible at 1, 2, 3, and 4 nautical miles is 2, 15, 21, and 106 respectively. According to experiments at Long Beach cited above, a green light of 3.2 c. p. was fairly visible at 1 mile, and of 28.5 c. p. clearly at 2 miles; these results, however, being from a limited number of experiments. The German trials were much more numerous.

"The extraordinary rapid limitation of the visibility of the green light with the distance, even in good observing weather, and the still more rapid decrease in rainy weather of a character which will but slightly diminish the intensity of a white light, show that it is of the utmost importance to select for the glass a shade of color which will interfere with the intensity of the light as little as possible."

The shade recommended is clear blue-green. Yellow-green and grass-green should not be employed, as they become indistinguishable from white at a very short distance. For the red a considerably wider range is allowable, but a coppery red is probably the best.

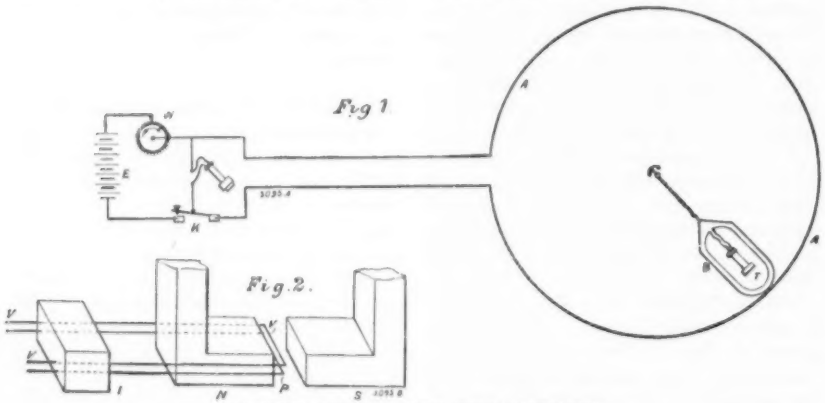
With regard to the loss which the light suffers in being transmitted by the glass, tests made show that this varies from 14 per cent. in the case of a perfectly clean glass to 51 per cent. in the case of one in the smoky condition due to a night's burning.

Electric Communication with Lightships.

ENGINEERING (Aug. 9) gives an account of a new apparatus about to be tried for the purpose named in the title. The breaking of cables between moorings and vessels, principally due to chafing, has led to the attempt at effecting communication "wholly by the inductive system, in which the cable lies on the bottom of the sea and the signals are transmitted over the intervening space to the apparatus on board by electro-magnetic induction. Following is a description of the apparatus to be used, which is the invention of Mr. Sydney Evershed of Woodfield Works, Harrow road, London.

"Fig. 1, not drawn to scale, shows a lightship B, able to swing around a mushroom anchor. Around the circle which it is capable of occupying there is laid, on the sea bottom, a ring of cable, A, connected to the shore station, as shown. A secondary coil is fixed on the ship, and should consist of, at least, fifty turns of insulated wire, of as low a resistance as possible. If the ship is built largely of iron, the secondary coil should be arranged around the outside of the bulwarks; its magnetic axis must be, as nearly as possible, normal to the plane of the ship's decks. Of course the coil must be as large as the dimensions of the vessel will permit. Interrupted currents are sent through the submarine cable by means of a key, *K*, and a contact-breaker, W, driven at such a speed as to interrupt the current several thousand times a second. The discontinuous currents in the cable ring, *A*, produce rapidly-alternating electro-mo-

tive forces in the secondary coil, and alternate currents pass through the telephone, *T*, and indicate their presence by the buzzing of its diaphragm. The signals are read by the Morse code. The difficulty with inductive telegraphy lies in calling the attention of the operator, as, of course, he cannot live with the telephone at his ear. This difficulty appears to have been removed by Mr. Evershed in an exceedingly ingenious manner by the invention of a cumulative impulse relay. Several forms of the instrument have been worked out, one of them, on the principle of the D'Arsonval galvanometer, being illustrated in Fig. 2. A rectangle of wire, *V*, is clamped in an insulating support, *I*. One side of the rectangle is placed between the poles, *N S*, of a powerful magnet, and, when the rectangle is traversed by alternating currents timed to correspond to its frequency of vibration, it receives a series of cumulative impulses, and is set in vibration. This vibration brings it against a contact on the similar rectangle, *P*, which is tuned in unison with *V*. When the two touch, the circuit of a local battery is closed, and a bell is rung. The two similar rectangles are used to prevent accidental contact due to mechanical jars. The second rectangle may be traversed by alternating currents in the opposite direction to the first. The currents employed in calling are not the same as those for speaking. A frequency of twenty to forty periods per second is suitable, and is obtained by means of a tuning-fork or other similar device. The vessel on which the induction telegraph is to be tried in the first instance is the East Goodwin, which lies outside the Goodwins, and will require a cable some 10 nautical miles in length."



ELECTRIC COMMUNICATION WITH LIGHTSHIPS.

PLANS for two new double-turret battleships for the U. S. Navy are being prepared. A smaller turret will be placed vertically above the large one. In addition to these vessels the Government is about to build three new torpedo boats, somewhat larger than those for which contracts were recently allotted. Their displacement will be about 185 tons and their speed 26 knots an hour. Water tube boilers will be used and the engines will be of 3100 H. P. One of these vessels will be built on the Pacific Coast, one on the Mississippi, and one on the Gulf of Mexico.

THE British warship *Terrible* was launched on the Clyde May 27. She is a first-class steel cruiser, copper sheathed, and of 14,250 tons displacement. Her indicated horse power is 25,000, and her speed is estimated at 22 knots. She is 531 ft. long and 71 ft. beam. She will be armed with two 22 ton, 9.2-in. guns, and 12 6-in. quick firing guns and 37 smaller guns.

IN his address before the American Association for the Advancement of Science, Mr. William Kent said that improvements in engineering methods often cause the destruction of vast amounts of fixed capital by the substitution of new appliances for the old. The British Government expended in 1864-70 £28,000,000 on a class of armored gun boats, which before any use was made of them, were condemned as worthless, owing to improvements in the construction of guns.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Technical Journals—See Introductory.

*687. The Growing interest in Yachting. W. P. Stephens (Importance of the yacht building industry as related to design of vessels, the cultivation of a taste for maritime sports, and diffusion of information relating to marine affairs among the people at large). Eng Mag-Oct. 3500 w.

*705. Lights on the Ocean (Results of special investigations undertaken by the United States, German and Netherlandic government officers, and published by the American hydrographic office). Marine Eng-Aug. 700 w.

*713. M. G. Meter. Ill Archibald Denny (Describes a new instrument for measuring the metacentric height of ships). Engng, Lond-Aug. 2. 2000 w.

*714. Experiments on the Strength of Cylindrical Shells. J. C. Spence (Records results of an experimental investigation). Engng, Lond-Aug. 2. 3800 w.

*722. The Distance and Time in Which a Ship may be Brought to Rest from Full Speed Ahead. W. D. Weaver (Formulæ for determining. The author has as yet been unable to compare calculated with actual results). Eng, Lond-Aug. 2. 1000 w.

*723. Traction of Boats on Inland Waterways. Ill. George Cowley (A contention that power haulage on canals should follow the two-line principle, with a strong argument sustaining the contention. Describes an electric locomotive for towing boats by tow-line haulage). Eng, Lond-Aug. 2. 1500 w.

*726. The Use of Bessemer Steel in Shipbuilding. Abstract of article by Henry Bessemer, published in the Engineering Review (Progress in construction of steel ships). Ir & Coal Tr Rev-Aug. 2. 900 w.

799. The Accident to the Steamer "La Touraine." Ill. (Plates of the hull sheathing loosened and cracked). Eng News-Aug. 15. 900 w.

800. The American Line Steamer "St. Louis." Ill. (Descriptive with editorial). Eng News-Aug. 15. 7800 w.

*809. New Dock Works at Southampton. Ill. (Descriptive). Engng-Aug. 9. 4000 w.

*810. The Dredger "Percy Sanderson" for the Danube Regularization Works. Ill. (Description of a chain-basket dredger, built and engined under the direction of Sir Charles Hartley, long identified with the improvement on the Danube). Engng-Aug. 9. 1500 w.

*815. Safety Liners for Propeller Shafts. Ill. (Descriptive). Engng-Aug-9. 400 w.

*818. Electric Communication with Lightships. Ill. (Evershed's apparatus. Descriptive). Engng-Aug. 9. 500 w.

827. Increase in Resistance of Vessels Traversing Shallow Water. Ill. I. McKim Chase. Eng-Aug. 17. 1600 w.

828. Sea Trial of the "Columbia," U.S. N. (Editorial which commends the voyage from Southampton to New York as an exceptionally fine performance and assigns reasons for this opinion). Eng-Aug. 17. 1200 w.

*934. Steam Windlasses and Capstans on the American Steamships "St. Louis" and "St. Paul (Illustrated, detailed description). Engng-Aug. 16. 900 w.

971. The Defence of the America's Cup. Ill. W. J. Henderson (Historical account of yacht racing since 1851). McClure's Mag-Sept. 2800 w.

972. The Cup Challenger "Valkyrie." E. L. Snell (Brief popular description). McClure's Mag-Sept. 700 w.

985. Cost of Running an Atlantic Greyhound (Itemized wages with incidentals). Ry Rev-Aug. 24. 600 w.

*997. Voyage of the "Antarctic" to Victoria Land. Abstract of paper by C. E. Borchgrevink (Account of voyage with scientific observations). Nature-Aug. 15. 2800 w.

1040. The Ninth International Yacht Race. Ill. (Discussion of the merits of Valkyrie III and the American yacht, Defender). Sci Am-Aug. 31. 1300 w.

*1085. Windlass and Cable Gears. Ill. (Plan and elevation of gear as used on H. M. S. "Terrible"). Engng-Aug. 23. 700 w.

*1147. The United States Cruisers "Columbia" and "Minneapolis" (A brief criticism on these war vessels as to their speed and use, accompanied by a photographic reproduction view of each). Am Eng & R R Jour-Sept. 1600 w.

1216. A Boom on the Great Lakes (Effect on the carrying trade). Sea-Sept. 5. 1300 w.

1217. Steel Canal Boats (Editorial discussion of cost, capacity and use). Sea-Sept. 5. 800 w.

†1220. Navy Boilers (Comparison of the Belleville water-tube boiler with other types for marine use). Ind & East Eng-Aug. 3. 2200 w.

*1238. The Coast Defense French Battleship "Bouvines." Ill. (A brief description of vessel with dimensions and armament). Eng, Lond-Aug. 30. 1500 w.

We supply copies of these articles. See introductory.

MECHANICAL ENGINEERING

Manufacture of Terminology.

THERE seems to be a tendency, when a new term is wanted for a thing or operation in practical mechanics, to seize upon the name which has been used in the shop where the thing or operation originated, regardless of its mechanical or scientific fitness to express all that it should. In this way many defective and awkward technical terms have come into use. Were the effect merely the creation of difficulty in the practical use of the term in speaking and writing, the practice would be less injurious; but the fact is that terms which are made to mean something that their derivation and previous use unfit them to mean lead to confusion and inaccuracy in thought, which is a serious objection to such use.

An example of such a term is "*producer gas*,"—a term which is now employed to signify gas made in so-called "*gas producers*" for use in gas engines, etc., the intention being to distinguish this kind of gas from ordinary illuminating gas. Now, the term "producer-gas" has in it nothing which, to one not previously instructed in its nature and uses, conveys the slightest notion of what it is, except the idea that it is some sort of gas artificially produced. But this is true of most gases; so, in reading about the increasing use and efficiency of gas-engines which use this gas, the lay reader, after a vain search for light upon the nature of the difference between this gas and illuminating gas, is forced to content himself with half-knowledge. The term "gas producer" is equally open to criticism; it really defines nothing. And it seems that in the art of using gas in heat engines there has been a singular outcrop of such insignificant terminology.

Our bright contemporary, *American Machinist* (Aug. 15), ably criticises one of these terms, "*impulse engine*," and asserts that this term not only fails to express the facts relating to the combustion and expansion of gas in engine cylinders, but that, as used, it conveys to most readers an entirely erroneous idea.

"To invent a new word, or even a new application of a standard word, is to incur a great responsibility in any event, and, in the case of an incorrect application of the word, it may cause serious trouble and misunderstanding. Someone has begun the practice, and now it is quite a common one, of speaking of the gas and oil engines of the day as 'impulse' engines. The idea intended to be conveyed, of course, is that the power developed by the engine and taken from the driving shaft for practical uses is first imparted to the piston suddenly and all at once at the instant that the explosion occurs. The use of the word 'impulse' in this connection, meaning by it a sudden application of force, is incorrect, misleading, and libelous. In speaking of the ignition and rapid combustion of the charge as an explosion, we are probably contributively culpable. The expression suggests not only an unsteadiness of revolution in the engine much greater than actually occurs, but also strains upon bearings, connections, and frame that never are encountered. We mentioned not long ago the desirability of some movement for the steam-engine indicator which would enable it to show us clearly what goes on in the cylinder while the crank is passing the center and the transitions of the steam currents are taking place. We have now in the gas and oil engines another place where such an arrangement is peculiarly desirable. We should be able to trace the ignition of the gas and the rise in pressure during the combustion. We know that it takes time. We know from our present indicator evidence that the increase in pressure is not in the nature of an instantaneous shock or of a blow struck, any more than the admission of steam in the steam cylinder is a sudden blow, because we see that the movement of the pencil of the indicator is not sufficiently rapid, and that it does not

acquire momentum enough to carry it beyond, or more than slightly beyond, the actual pressure attained and represented. The indicator tells us even now that these engines, so far from being 'impulse' engines, or being driven by a blow like that of a sledge upon the piston at the beginning of the working stroke, are instead more truly expansive engines than any steam engine that ever existed, and that the driving by expansion continues for the entire stroke, while in the steam cylinder the expansion is only for the portion of the stroke remaining after the cut-off. No steam engine runs by expansion alone, as the gas engine does. There is always a certain portion of the stroke, when the cylinder is filling with steam, and by its pressure driving forward the piston, which certainly does not do that work by the expansion of that charge of steam; and only after the cut-off is the work of expansion done. But the diagram from the gas engine shows us that with it 'cut-off' has occurred before the beginning of the stroke, and the entire force of the driving stroke, from the beginning to the end of it, is due to the continued expansion of the burnt gases contained in the combustion chamber and in the clearance spaces at the beginning of the stroke. Of course, we understand that in these engines every stroke is not a driving stroke, and that in some of them the intervals of intermission vary according to the power or speed requirements, but we must protest that to call the engines 'impulse' engines gives us no hint of this peculiarity, but that it does give us a hint of something that does not exist."

A literary and scientific bureau of experts, to which new technical terms might be referred for approval before their use could be regarded as authorized, would be very useful. The work of such a bureau might profitably be extended to the revision of terms already in use. The number of words now used in the arts as technical terms is great. Different words are used in different English-speaking countries to signify the same thing; and even in the same country in different localities things are called by different names. Many an American reader perusing an English technical paper will find terms entirely unfamiliar to him, which, when he has ascertained their meaning, he discovers to be used to indicate familiar things or processes. Difficulty and confusion are thus created that might be easily avoided by the authoritative action of some competent body in the adoption or exclusion of technical terms.

The Efficiency of Heating Surfaces in Steam Boilers.

ENGINEERING for July 12, in discussing the efficiency of heating surfaces in steam boilers, says that the erroneous statement so often made that heat passes from the furnace gases to the water in a boiler at a rate which varies directly as the difference between the temperatures of the two fluids probably originated in a misapplication of the following sentence, which occurs on page 258 of Rankine's "Steam Engine": "The rate of conduction through a flat layer of uniform thickness is simply proportional, directly to the difference between the temperatures of the two surfaces of the layer, and inversely to its thickness." It points out, however, that Rankine was speaking only of what takes place in the substance of a homogeneous plate, the two surfaces of which are maintained at known temperatures: whereas in boiler work the only temperatures dealt with are those—known or assumed—of the water and gas respectively.

It has been shown by Dr. Kirk that, as the thickness of the plate was reduced, its temperature became more nearly that of the water, the two temperatures becoming equal when the plate is ¼ in. thick.

The principal cause, after soot, of the great difference found in practice between the temperature of the furnace gas and that of the dry side of the plate is probably the fact that, as soon as the layer of gas next the plate has given up part of its heat, it forms a badly-conducting screen, which prevents the rest of the hot gas from touching the plate till it has moved out of the way by connection or otherwise. The varying resistance due to this layer of comparatively cool gas is assigned as a

reason, though perhaps not the only one, why the above-quoted sentence of Rankine is not applicable to boiler problems.

In some experiments by Blechynden, he found that the influence of thickness on the rate of heat transmission was small, even with perfectly clean plates, while it was practically *nil* when the plates were at all dirty. From experiments by Stromeyer, *Engineering* concludes that the rate of transmission varies as the *square* of the difference of temperature, or, in other words, that the rate of transmission *per degree of difference* is simply proportional directly to the difference between the temperatures of the water and the furnace gas.

It quotes Mr. Blechynden in support of this statement that the efficiency of heating surfaces varies as the square of the difference of temperatures, and insists upon the importance of making this difference as large as possible by means of rapid combustion, obtained by fan blast or high chimneys. It cites the fact that Mr. Thomas Fletcher of Warrington, in a lecture delivered in 1886, distinctly foreshadowed the Serve tubes, and described the increased efficiency he had found with internally-ribbed flues. This was ascribed to the fact that, as the conducting section of the ribs was small in comparison to their heat-absorbing surface, they soon reached the critical temperature at which flame contact was possible.

Mr. Fletcher exhibited two vessels,—one with a plain bottom, the other with studs projecting from its under surface. Although the surface of the latter in contact with the water was stated to be only half that of the plain vessel, it boiled a gallon of water in little more than half the time required by the plain vessel, so that the studded surface was over three times as efficient as the plain surface.

He also boiled water in a vessel placed over a powerful gas-burner of the Bunsen type, and showed that a piece of paper, which would char if raised to a temperature of 400° F., was not discolored when pasted under the bottom of the vessel used as a boiler. When the eye was placed on a level with the bottom of the vessel, a clear space was seen between it and the flame. The thickness of this space exceeded that of the paper by about $\frac{1}{40}$ in.

Mr. Blechynden used vessels having thick bottoms made of boiler plate, in which he boiled water at atmospheric pressure. Their sides were carefully protected from flame and radiation, so that all the heat reaching the water had to pass through the bottoms of the vessels.

A mass of asbestos lumps, covered by a sheet of wire gauze, was maintained at a steady heat by gas-burners, this being found a more constant and uniform source of heat than a naked flame. The units of heat passing per degree of difference of temperature were calculated from readings of three thermometers,—one in the water, one immediately under the boiler, and the third immediately over the heated wire gauze,—and the result of these experiments was the determination that the efficiency of heating surface varies as the *square* of the difference of temperatures.

Engine Foundations.

In line with what is said above regarding boiler efficiency, an article in *Lord's Power and Machinery Magazine* for July discusses defective and effective engine foundations. It quotes a prominent engine builder as saying that "more than half the trouble with engine alignment after a few years' run, also many other ills which an engine is heir to, might be traced directly to improperly-laid foundations." The article proceeds to give the following specific directions for constructing engine foundations:

"The first thing to take into consideration is the character of the soil. Should it be solid rock, why, then, all that would be necessary would be to drill and place the anchor bolts, but this is very seldom seen. If the soil is very spongy, then piles should be driven, and on top of them iron rails should be laid crosswise for several layers and the squares filled in with Portland cement. This forms what might be called a sub-base, on top of which the regular foundation is to be laid.

"If the soil is sandy, piles are seldom necessary, except in case of quicksand, but, instead, a trench should be dug below

the frost line and filled with broken stone puddled with cement. On top of this should be laid the anchor stones, say 6 ft. long by 18 in. wide by 9 in. thick. They should be drilled to have the anchor bolts pass up through them, being held on the bottom by large nuts and wide iron washers. These bolts should be of sufficient length to give proper depth to the foundation, which is governed wholly by the size of the engine. The space between the bottom and the cap, or top foundation stones, should be filled in with broken stone and cement, using plenty of the latter. This makes a solid, immovable foundation for an engine of any size, which can be set directly on top of the trenches; but in many cases owners are compelled to place their engines higher in the air; then brick piers are necessary. In this case the cap stones are carried up to the desired height and the space filled in with brick. A hard-burned brick should be used and put together with a very little carefully-prepared cement. Masons generally use for this work the best quality of Rosedale cement mixed with not more than two parts of sharp sand. The bricks should be wet before being used, and, after setting, should be allowed 2 weeks to become perfectly solid.

"Whenever it is possible, the anchor bolts should run from the bottom up through the engine bed, which is easily arranged, so far as proper placing is concerned, by using a wooden template, furnished with every engine, to guide the foundation builders. This does away with a second set of bolts for the engine; but, when this is not feasible, then the bolts holding the engine frame to the foundation are placed only in the cap stones.

"When the anchor bolts are to be used for both purposes, it is always well to leave a trifle of play-room around them. Say, for instance, for a 1¼-in. bolt a 2 in. hole should be left in the foundation.

"The template has, or should have, a line drawn through it representing the entire line of the engine from cylinder to crank, and in a line at right angles with this to correspond with the line of the engine shaft. With these it is easy to set in the template just as the engine would be set up with the shaft line exactly parallel with the shafting in the building, or where it is to come.

"Where a separate set of bolts is used for the engine, taper bolts are required, which should be noticed. These are placed in holes drilled in the cap stones, which, after the engine is in place, are filled with sulphur.

"When this is all finished, the engines must be put in place of the template. In doing this the bed is put in position, resting upon iron wedges, so placed that any part of the engine frame may be raised or lowered. The engine must then be brought in line or parallel with the shafting, and must also be perfectly level, and levelled and lined within itself; that is, each portion of the engine must be level and in line with each other part, as well as with the shafting. The nuts are then screwed down, but not to their full extent, and the engine is raised or lowered by the wedges, until it is perfectly level; and, when we say level, we mean that 'near enough' will not do, for, in order to run satisfactorily, the machine must be 'plumb level and square.' When the engine is thus leveled and lined, it is ready for its bedding. This bedding is either sulphur or cement put in liquid form between the engine bed and the foundation stone, to set the bed where it now is, the sulphur or cement soon hardening as hard as the rock itself. Some makes of engines have a hollow chamber in the bed plate, which is intended to be filled with cement and gives it the added firmness, as settling it down over the rock would. To properly pour sulphur is something of a task, demanding considerable care, first in pouring, and also watching to see that the sulphur does not get too thick from overheating. The sulphur used is heated or melted in pots, but, if heated too much, it becomes thick and will not fill all the crevices before hardening, making the same difficulty which is often experienced in the foundry when the melted iron is not sharp enough.

"To do the pouring, a runner of clay is built around the engine bed, or, in other words, a little trough all around, about an

inch from the edge of the bed. The melted sulphur, when poured into this trough, runs under the frame, filling all the space between the frame and cap stone. It is usually necessary to divide the pouring into sections, not attempting to pour it all at once, as it is apt to cool too quickly if one tries to cover too much surface. Where sulphur is used, the hollow space inside of the engine frame, if there is one, is blocked with hemp or other material to keep the sulphur from running in, as it is never used in quantities like the cement mentioned above. Before the whole is set, screw down gradually on the bolts, a little at a time, until the engine is securely held in position on the foundation, care being taken not to disturb the level of the engine."

Wind as a Motive Power in the United States.

THE popular idea that the use of wind power in the United States is but slowly advancing is shown, in an article by Frank Waldo, Ph. D., in the September number of *The Review of Reviews*, to be an error. On the contrary, progress in the utilization of wind power has been rapid and extensive. "Over one hundred firms" in the country "are engaged in the manufacture of wind wheels," and the author thinks "it would not be excessive to estimate the total number of wheels at present in use at upward of half a million." He also estimates the annual increase at "over fifty thousand. . . . Probably 60 per cent." of the firms engaged in this manufacture are "within 200 miles of Chicago. About eight firms are located east of Ohio. . . . . About half a dozen are located on the Pacific coast."

The uses to which power thus obtained is applied are various, but the chief use is the pumping of water, not alone for domestic supply, but for irrigation and other purposes. Farm implements, such as churns, feed-cutters, etc., are frequently driven by wind wheels. The author expresses the belief "that the utilization of wind power by means of wheels as a pumping force will be the main method by which our arid regions in the west will be reclaimed by irrigation." He also looks forward to an extension of the use of wind power in the "accumulation of electrical energy when a convenient storage system shall have been put on the market."

The amount of available wind force and its constancy are discussed from data obtained from records of the United States Signal Service and Weather Bureau, and four charts are given, representing "lines of equal wind velocities" in the United States,—two for January, and two for July. Of the two charts for each of these months, one gives the lines of equal wind velocities, and average velocities in miles per hour, for "well exposed stations," and the other gives the same data for "low exposed stations." The information thus afforded is of value as an addition to engineering data.

The proposition to substitute non-adjustable wind wheels for the self-adjusting ones now in use is also considered, with apparent approval of the system. Instead of presenting the entire face of the wheel to the wind, as do the self-adjusting wheels, the proposed system contemplates the use of "large non-adjustable wind wheels, somewhat after the fashion of the stern wheels on western steamboats, the axis of the wheel being arranged transversely to the prevailing wind direction. Of course the return half of the wheel would have to enter a box, or be so otherwise protected that the wind should not strike it. If such a wheel is made to revolve horizontally around a vertical axis, it could be placed in a fixed position, and the light shelter-box could be made adjustable for any side," or it could be made "automatically adjustable."

Lignum Vitæ Bearings.

IN *American Machinist* (July 18) Mr. J. McKim Chase says that his early experience with lignum vitæ bearings for machinery leads him to wonder why this substance is not more used for bearings, gibs, etc. He advocates its use "whenever opportunity and the conditions of the case are favorable," and gives suggestions for using it to best advantage. He says that for this use "it should always be ar-

ranged so as to take the wear on the end of the grain. In this position, when efficiently lubricated and not subjected to excessive pressure, its resistance to wear is somewhat astonishing. When the wear is taken on the side of the wood, or with the grain, it is less durable, and lubrication is more imperative. When run dry on the side of the grain, a much softer material will wear it rapidly, as may have been observed in the case of a boy's wagon having wheels of lignum vitæ and axles of some other wood. As a lubricant for lignum vitæ, water appears to be as efficient as oil, especially when the bearing is on the end of the grain, but the supply of water should not be stinted."

Mr. Chase gives his experience with this material for crosshead gibs on a double marine engine of the inverted vertical type, having very short connecting rods, which caused much trouble with the crosshead gibs. After the return of the vessel to Baltimore from Charlestown the gibs nearly always required renewal or lining out. "After several different materials had been tried with indifferent success, I induced the engineer to substitute lignum vitæ. He expressed great doubt as to its success, chiefly on account of the limited thickness available for the wood. However, I recessed the pattern which had been used for the metal gibs, and managed to get a depth of about ¼-in. thick. The gibs being prepared, I fitted lignum vitæ into the recesses, with the end grain bearing on the guides. No necessity was found for fastening the wood to the gib castings, because, when in their places in the engine, the wall of metal around the recesses prevented the wood from getting out. And I can testify that no further trouble was experienced with those gibs while I remained at the establishment where the vessel was repaired, which was several years after the lignum vitæ had been applied."

Having also tried it in the stern bearings of propeller shafts, fitted with it so that the bearing should be on the end of the grain, and also for the end bearing of a vertical shaft, he found it equally satisfactory. "Feed the lubricant into the center of a bearing of this character."

THE ENGINEERING INDEX—1895.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Technical Journals—See Introductory.

The Machine Shop.

*725. Notes on Modern Steel Works Machinery. James Riley (Notes progress in this class of machinery as tending toward increased strength and power, with reference to important machines in use in many large establishments). Ir & Coal Tr Rev–Aug. 2. 5500 w.

879. Burnt Steel (An application of theory). B. F. Spalding. Age of St–Aug. 17. 1800 w.

897. Making a Miter-Gear Pattern. Ill. P.S. Dingey (A practical discussion of a method of making this class of patterns, wherein the teeth are separately made and fastened on the rim). Am Mach–Aug. 22. 1100 w.

902. The Use of Milling Machines. Henry B. Binsse (Milling machine economy is regarded as a function of the duplication of the product). Am Mach–Aug. 22. 1600 w.

1017. Some Special Tools in the Cincinnati Milling Machine Company's Shops. Ill. John Randol (Describes some very interesting machine tools and fixtures used for special work of difficult form and wherein first class fitting is required). Am Mach–Aug. 29. Serial. 1st part. 2000 w.

1048. The sharpening of Files by Sand Blast. Ill. Mr. Desgeans and Mr. Fort (Description of process). Sci Am Sup–Aug. 31. 1700 w.

1161. Drawings for the Shop. Ill. C. H. Benjamin (A systematic method of making working drawings). Mach–Sept. 2200 w.

1164. Modern Machine Shops. Ill. (Shops of the De La Vergne Refrigerating Co.). Mach–Sept. 2200 w.

1223. Roll Lathes and Roll Turning. Ill. A. Randolph (Description of tools and methods in use at shops of Robinson-Rae Mfg. Co., Pittsburg, Pa). Mach–Sept. 1300 w.

Steam Engineering.

*699. Lancashire Boiler Setting. H. O'Connor (Reasons for methods adopted, rules for calculating area of flues and chimneys, materials used, etc). Ill Car & Build–Aug. 2. 1400 w.

*868. The Measurement of Jacket Water in a Gas Engine. Frederick Grover (Describes a method and apparatus). Prac Eng–Aug. 9. 900 w.

*869. Arndt's Oekonometer. Ill. (Describes this instrument, the purpose of which is to determine the degree of efficiency in the regulation of combustion in boiler furnaces. An index finger indicates the efficiency). Prac Eng –Aug. 9. 1100 w.

*870. The Bulging of Locomotive Firebox

We supply copies of these articles. See introductory.

Sheets. Ill. (Report of a committee of the Am. Mas. Mech. Asso. specially appointed to investigate this subject). Frac Eng-Aug. 9. 1400 w.

898. High Speed Without Knock. Charles T. Porter (An argument proving that an engine cannot knock on the centers unless compression exceeds boiler pressure before the induction port is opened for admission of steam). Am. Mach-Aug. 22. 1000 w.

900. Novel French Boiler-Heated Feed Water. W. H. Booth (Describes a new, so-called, self feed water heating boiler of French design). Am Mach-Aug. 22. 1100 w.

1004. Expansion of Steam Pipes (How much it is. The conditions affecting it). Bos. Jour Com-Aug. 24. 1700 w.

1011. National Association of Stationary Engineers—Educational course. Sixth lecture of Prof. R. E. Carpenter (The steam engine indicator; use; indicated and dynamometric power; parts; reducing motion; indicator card; accuracy; calibration of indicator spring; test for parallelism of the pencil movement to the axis of the drum; to adjust and calibrate a drum spring; method of attaching; directions for taking diagrams, etc). Safety V-Aug. 15. 4500 w.

1014. On Governing Steam Engines by Throttling and by Variable Expansion. H. Riall Sankey (An argument to show that while the general verdict favorable to variable expansion governing may be accepted, its advantages are overrated, and in some cases *nil*). Safety V-Aug. 15. 3000 w.

1016. Various Kinds of Slide Valves. Charles A. Hague (The gradual decline in the use of slide-valves for automatic stationary engines is noted and its shortcomings discussed, followed by remarks on the design and setting of this class of valves illustrated by diagrams). Am Mach-Aug. 29. 2200 w.

*1075. Steam Engine Economy: Condensing Engines. Henry Davey (Discussion illustrated by diagrams and cards). Ind & Ir-Aug. 23. 3500 w.

1129. Heating Surface of Boilers. C. W. Maccord, Jr. (Discussion of what constitutes the heating surface of a boiler, with tables giving standard dimensions). Power-Sept. 1000 w.

1155. Mechanical and Electrical Regulation of Steam Engines. Ill. (John Richardson in the Pro. of Inst. of Civ. Eng. A valuable article on steam engine governors). Ir Age-Sept. 5. 3300 w.

1231. The Purification of Boiler Feed Waters. Francis Wyatt (A general article on renewal of solid matter in solution in water used for steam). Eng & Min Jour-Sept. 7. 1200 w.

1242. The Effect of Oil in Steam Boilers (Showing the tendency of oil to deposit over particles in the boiler water and deposit along with them, forming a still more dangerous scale). Ry Mas Mech-Sept. 900 w.

Miscellany.

*693. Racial Traits in Machine Designing. Albert Williams, Jr. Eng Mag-Oct. 3500 w.

*700. Smoke Prevention (Account of various patented devices for smoke prevention). From Locomotive Engineer. Ill. Car & Build-Aug. 2. 1700 w.

*702. Recent Progress in Steel Casting. H. L. Gault (Paper read at A. S. M. E). Prac Eng-Aug. 2. 2400 w.

747. Strengthening of Permanent Way (Abstract of paper read by William Hunt at International Railway Congress. Section of rail and calculations of strain imposed by rolling load). Ry Age-Aug. 9. 1600 w.

763. The Honsby-Ackroyd Oil Engine. Ill. (Descriptive). Ry Rev-Aug 10. 2000 w.

791. The Daimler Gas and Petroleum Motor. Ill. (Descriptive). Sci Am Sup-Aug. 17. 1700 w.

794. "Impulse" Engines Without the Impulse. Editorial (A criticism of terminology). Am Mach-Aug. 15. 600 w.

795. The Draw Cut (A study of the action of cutting tools). Am Mach-Aug. 15. 1500 w.

*813. The Strength of Metals at High Temperatures (Reviews modern experiments, and gives a table of tenacities of various metals and alloys at various temperatures). Engng-Aug. 9. 900 w.

*816. Locomotive Piston Rods. H. Rolfe (Discusses the subject of enlarged ends and current notions regarding this feature; tail-rods; thrust of piston opening crossheads; valve-spindle sockets; turning down rods for wear; material for rods; screw ends; etc). Engng-Aug. 9. 4800 w.

*857. Coal Elevating and Conveying Machinery. Ill. (Coal taken from barges and deposited in any part of the coal store at the rate of 20 tons per hour. Coal raised by steel buckets). Eng, Lond-Aug. 9. 1300 w.

863. The Foundry Yard. A. Sorge, Jr. (Proper and systematic arrangement and care of materials should be one of the principal duties). Ir Tr Rev-Aug. 15. 2200 w.

*864. Notes on Modern Steel-Works Machinery. James Riley (Abstract of paper read before the Inst. of Mech. Eng., Glasgow. Rolling-mill engines; logging mills; hydraulic slab shears; slab-cutting shears; plate mills; hydraulic forging-press cylinder; &c. Discussion). Ind & Ir-Aug. 9. 7800 w.

*865. Some Notes on Circular Saws. Ill. W. Samuel Worssam (Manufacture; re-hammering; manipulation). Ind & Ir-Aug. 9. 3500 w.

*877. The Testing of Oil Engines. Professors Hartmann and Schöttler (A trial of agricultural oil engines made by the German Agricultural Society, at Berlin, in June, 1894). Col. Guard-Aug. 9. 2800 w.

899. Gasoline Road Carriages. W. H. Booth (Sets forth the advantages of this class of motors for mechanically propelled vehicles). Am Mach-Aug. 22. 1000 w.

901. Inspection of Material at Rolling-Mills (Editorial. A criticism of methods used by the Carnegie Steel Company). Am Mach-Aug. 22. 1000 w.

903. Hints on Core Rooms. Herbert M. Ramp (A very thorough, practical discussion of core-room practice and appliances). Mach Mold's Jour-Aug. 2500 w.

905. A Foundry on Wheels. Ill. (Describes a portable foundry for joining railway rails with molten iron as used by the Pleasant Valley Railroad Company). Mach Mold's Jour-Aug. 300 w.

907. The Thorne Typesetting Machine. Ill. (Description of operation of type-setting with this machine). Sci Am-Aug. 24. 1700 w.

917. Some Recent Fuel Handling Machinery. Ill. (N. Y. C. & H. R. R. at East Albany; N. Y. L. E. & W. at Buffalo). R. R. Gaz-Aug. 24. 600 w.

*932. Some Peculiarities of Cast Iron (A discussion of Keep's tests. Comparison of these tests with that of bars 2 in. by 1 in. in section—the common English method). Engng-Aug. 16. 2000 w.

951. English Plate Mills (Discussion and comparison with mills in the United States). Am Mfr & Ir. Wld-Aug 23. 1200 w.

*977. The Haythorn Tubulous Boiler. Ill. (Construction and description). Eng, Lond-Aug. 16. 700 w.

1013. Lubricants and Lubrication (Describes chemical and physical qualities and application of lubricants in practice). Safety V-Aug. 15. 1700 w.

1025. Method of Determining Dimensions of Oval Passes. William Hirst. Ir Age-Aug. 29. 600 w.

*1027. Cost of Steam and Water Power in Montana. M. S. Parker (Read before the Montana Society of Civil Engineers. Discussion with tables). Jour Asso Eng Soc-July. 800 w.

1053. The Uses of Stone Implements. Gerard Fowke (A few uses to which stone implements were put). Archaeologist-Sept. 2000 w.

*1079. The Cornwall Works, Soho. Ill. (Visit of Ir. & St. Inst. to the Tangye Works and to the Staffordshire Steel and Ingot Co.'s works, England). Eng, Lond-Aug. 23. 3000 w.

*1083. The Measurement of Jacket Water in a Gas Engine. Frederick Grover (Calculation in detail). Gas Wld-Aug. 24. 1100 w.

1109. The Exhaust Fan or Blower. C. R. Tompkins (Its application to carrying shavings from planing mill machines). Age of St-Aug. 31. 1300 w.

1114. The Western Union Cold Storage Plant. Ill. (Description of a very large plant). Sta Eng-Sept. 1300 w.

1115. The Water Supply. Otto Luhr (Conditions affecting the supply in refrigerating plants). Sta Eng-Sept. 1800 w.

1116. The "Central Valve" Engine. Ill. (Description with section). Sta Eng-Sept. 800 w.

1121. On the Economy and Future of Motors Driven by Explosive Mixtures. Extract from paper by C. Lambette (Comparison of two, ten and fifty H. P. motors each driven by gas, petroleum and steam). Am Gas Lgt Jour-Sept. 2. 1200 w.

1123. The Old and the New. Robert Allison (Read at the Detroit meeting of the A. S. M. E. A reminiscent paper with discussion). Sci Mach-Sept. 1. 2000 w.

1124. The Woburn Boiler Explosion. Ill. (Description). Sci Mach-Sept. 1. 1800 w.

1127. Air Pumps and Water Shocks. A. Bollinckx (Causes leading to water shocks in the cylinder of steam engines and the prevention thereof). Power-Sept. 1100 w.

1128. Testing Room of the Westinghouse Machine Company. Ill. (Brief description of apparatus). Power-Sept. 600 w.

1130. The Influence of the Amount of Air in Combustion on the Economy of a Furnace (Discussion, illustrated by diagrams, especially in relation to boiler furnaces). Power-Sept. 900 w.

1131. Rules and Tables for the Equalization of Power Developed in the Cylinders of Compound Engines (A copyrighted article by the Philadelphia Engineering Works, containing valuable rules for designing and tables of data). Power-Sept. 1800 w.

1132. Mechanical Draft. Henry B. Praither (Paper read before the Eng. Soc. of Western N. Y.) Power-Sept. 1800 w.

*1138. Trials of Oil Engines at Meaux, France (Condensed article giving results of trials of eight engines). Prac Eng-Aug. 23. 1500 w.

*1139. Tests of Engine and Boilers at the Milton Spinning Co., Mossley (Results of systematic tests in detail, illustrated by cards and diagrams). Prac Eng-Aug. 23. 1600 w.

*1140. Faulty Iron Castings. Walter J. May (Removal of impurities by the use of ferro-sodium). Prac Eng-Aug. 23. 800 w.

1153. Bending Large Pipe by Hand. Ill. (Description of method used in a New York City shop). Ir Age-Sept. 5. 350 w.

1154. Foundry Costs. A. Sorge, Jr. (Classification under the heads of labor, material, and other expenses of the cost of operating foundries). Ir Age-Sept. 5. 2000 w.

1163. Something about "Starting Up" New Plants. William O. Webber (Valuable practical details in installing new machinery). Mach-Sept. 1600 w.

*1177. Wind as a Motive Power in the United States. Frank Waldo (The uses to which windwheels are put; questions to be determined in the use of power; some desirable matters for future investigation). Rev of Rev-Sept. 2800 w.

*1234. Modern Oil Engines. Ill. (Description of the Hornsby-Ackroyd patent safety engine). Chem Tr Jour-Aug. 31. 1500 w.

1275. The Measurement of Jacket Water in a Gas Engine. Frederick Grover (Assumes that the jacket water must carry away 36% of the heat, and describes a tank arrangement whereby the required jacket water used may be measured). Am Gas Lgt Jour-Sept. 9. 1200 w.

We supply copies of these articles. See introductory.

MINING & METALLURGY

Illuminants Used in Mines.

SOME of the most disastrous accidents about our coal mines have been caused by the explosion of gases through the careless use of a naked-flame lamp or candle; and, though the introduction of the Davy lamp decreased the number of such catastrophes, accidental explosions are still sufficiently frequent to cause both miner and manufacturer to look for a safe light. Mr. A. H. Stokes, H. M. Inspector of Mines, has touched upon this subject, along with some practical points relating to mine illuminants in general, in a paper read before the Chesterfield and Midland Counties (England) Institution of Engineers, at its meeting of July 13. Thirteen series of experiments were made to compare the standard candle with the various oils used in safety lamps. The *American Manufacturer* refers to these experiments as follows: "With only one gauze and a lamp gauze having one-third of its internal surface enameled white as a reflector, the measure of increased light in a forward direction was found in some cases to be more than double that given by the same oil and wick in the previous experiment. Comparisons of the standard candle with tallow and wax composite candles of various specified sizes showed that miner's candles, as ordinarily used, gave a greater amount of light than the sperm candle, and generally an equal intensity with the safety lamp. An experiment with the recently-introduced Sussman portable electric lamp showed the intensity of light to be practically the same as that of the standard sperm candle.

"Practical suggestions were made as to the several parts of the safety lamp, such as that the wick tube for a flat wick should be corrugated on one side and be only slightly less in width than the wick to be used in it; and an improved form of pricker for snuffing the wick was recommended. The results of the experiments clearly pointed to the conclusion that the value of an oil for illuminating purposes could best be known by actual photometric experiment. Seed oils, where burned alone, had a tendency to form a crust, and required frequent snuffing, but, when mixed with petroleum, they gave good results. The mixture suggested by the royal commission on accidents in mines was believed to be one of the safest and best illuminants that could be used in safety lamps,—*viz.*, a seed or refined colza oil of good quality, mixed with a paraffin oil of a flashing point not lower than 80° F., in the proportion of not more than one part by measure to two parts of the vegetable or mineral oil.

"The object of the addition of the petroleum was two fold: (1) To reduce the viscosity of the seal or colza oil and to increase its capillarity, and (2) to supply a mixture of hydrocarbon oil that would increase the illuminating power of the flame by rendering it white and clearer burning than when pure vegetable oil was solely used. The price of an oil did not appear to be any guide to its value as an illuminant, either in respect to light or lasting properties. Some of the cheap oils compared favorably in such respects, under the same conditions, with higher-priced ones. To obtain good light from a safety lamp, cleanliness and care must be the motto of the light cabin, and their intent and meaning should be strictly enforced."

It were well if those mines using large quantities of supplies would adopt the plan successfully carried out by our larger railroads. Here all purchases of oils, lubricants, paints, etc., are made on specifications, and the material tested as received, thus relieving the supply department of all blame for inefficient work or accidents. The plan works well, and, in the case of illuminating oil for miners' lamps, would save the miner much vexation and the company many a lamp. Mr. Stokes has treated the subject in a thoroughly practical manner.

United States Coal Production.

THE United States Geological Survey has issued a report upon the coal trade of the country prepared by Mr. E. M. Parker, which includes a description of the several localities, along with statistics of production for 1894. He groups the bituminous coal fields into seven divisions, as follows: (1) The triassic areas of the Richmond Basin, Virginia, with a production in 1894 of 52,079, short tons, while the North Carolina mines produced 16,900 short tons. (2) The Appalachian field, which follows the Appalachian mountain range from Pennsylvania to Alabama, and produced in 1894 76,278,748 short tons. (3) The northern field, in Michigan, occupying 6700 sq. miles in its central portion, with a production of 70,022 short tons. (4) The central field, embracing Indiana, Illinois, and western Kentucky, with a production in 1894 of 22,430,617 short tons. (5) The western field, between the Rocky mountains and the Mississippi river, with a production of 11,503,623 short tons. (6) The Rocky mountain field, embracing the deposits in Colorado, Idaho, Montana, New Mexico, north Dakota, Utah, and Wyoming, with a production in 1894 of 7,175,628 short tons. (7) The Pacific coast field, embraced by California, Oregon, and Washington, with a production in 1894 of 1,221,238 short tons. The anthracite areas are said not to exceed 480 sq. miles in extent, and have produced since 1820 about 1,000,000,000 long tons. The producing areas lie in central and eastern Pennsylvania, though small quantities of inferior anthracite are produced in Rhode Island, Arkansas, and Colorado. The total production of both anthracite and bituminous coal in 1894 was 152,447,791 long tons, equivalent to 170,741,526 short tons, with a value at the mines of $184,141,564. These figures are for the total quantity mined, including all coal raised from the mine, and are the best obtainable.

The Trouble With Our Southern Gold Mines.

THIS is the title of a strictly general talk by Mr. Courtenay De Kalb in the *Manufacturers' Record* (Aug. 16). Considerable interest is manifested in these properties by English and French capitalists at the present time, and southern speculators are holding their properties at exorbitant and ridiculous prices. It were unfortunate in this period of rapidly renewing confidence that European capital should first settle on southern gold properties, for, to quote Mr. De Kalb, "if we should review the history of gold mining in the South, we would find that it consists largely of a chronicle of disasters. We should find that those few mines which have shipped large amounts of bullion have in nearly all cases been financial failures. . . . This can be explained, almost without exception, by the simple phrase 'over-capitalization'; . . . The mine was sold to credulous people at too high a price, and subsequent developments were made on too extravagant a scale." He likewise states that the people are imposed upon by professed mining experts, and that they never develop their deposits sufficiently to enable themselves or the purchaser to estimate its actual value. In speaking of this he says: "The majority of our southern mine-owners dream extravagant dreams over the value of their undeveloped veins. Because they can trace them for long distances upon the surface, and by a few open cuts and shallow pits extract here and there fancy specimens of 'gold quartz,' they are convinced that they own a great mine, and they think that everyone else should be satisfied with such evidence; but, as a matter of fact, it amounts to very little in the eyes of an experienced man. It shows that there is some gold there, but proves nothing as to the amount. And yet upon this feeble showing the highest hopes are founded and enormous prices asked, which serve no other purpose than to erect another barrier against the profitable exploitation of the property." The southern miner is not yet settled into the mathematical business ways of his more experienced neighbor in the north and west. Though some deposits are paying expenses, it is only through economical treatment.

New Method of Hardening Steel.

THE above is the headline of an editorial in *The Railway Review* (Aug. 31). Cementation was practised years ago by the iron masters of Great Britain, but reappeared successively under such names as "case-hardening" and "Harveyizing," and once more as an "invention" in which "the process is based on the fact that gas under great heat deposits carbon in a solid form." This is often true, though it is more often the case that highly-heated carbonic oxid deposits carbon on any surface cooler than itself. Consequently, when gas is admitted between two pieces of steel so arranged that it cannot escape, it deposits its carbon on the surface of the steel in very close contact with the steel itself. In the Harvey process for tempering armor plates a layer of carbon mixed with some animal charcoal is placed between two superimposed plates. In the "improved" process a more intimate contact is claimed and a consequent greater absorption of carbon. This is a proper claim, and a decided improvement over the usual process of applying carbon in the shape of pulverized coal or charcoal directly to the surface, especially where intimate contact is hard to obtain on account of caking or coking of the carbon, leaving vacant spaces. To quote from the report of the American consul in Germany on this process as used at the French works of Schneider & Cie., Creusot, "Schneider's process puts two plates into the furnace, one on top of the other, with a hollow space between them. This space is made gas-tight by means of asbestos packing put on around the edges. The plates are heated red-hot [bright salmon in the case of the Harvey process.—ED.], and a stream of light gas is poured into the space between them. The carbon thrown off by the gas is deposited on the plates, until they are thickly covered. The depth of carbon covering can be regulated by the quantity of gas admitted. In order to secure regular and uniform action during the process, and to prevent the pipes that carry the gas to the hollow space from absorbing any of the carbon, they are insulated in other pipes through which water is constantly circulating. It is believed that this simple and rapid carbonizing process will soon be applicable to other branches of the steel industry." Tempered carbonized steel possesses such a degree of hardness that it can not be dented with a center punch, and is not in the least affected by a file. Therefore it is remarkable that all wearing parts, such as engine guides, journals not subject to shock, and similar parts, are made of soft material easily scored by grit or excessive pressure and requiring repeated renewals.

The World's Gold and Silver Production.

IN arriving at statistics representing the production of the precious metals in any country, there are many difficulties to contend with which do not appear on the surface. Gold may be valued at anywhere from $15 to $20 per ounce, depending upon the quantity of other metals or impurities with which it may be associated. Small producers in remote localities often refuse to give their production, or grossly exaggerate their reports to suit their private ends. It is very difficult to avoid duplication, for, if the ore is smelted in Mexico, refined in the United States, minted in Europe, and converted into tourist curios, which afterward pay duty at San Francisco, it is extremely difficult to tell positively where it did come from, as it will appear on the books of the mining company, the Mexican export reports, twice on the United States import returns and once on the export returns, once on some European mint report, and also on bank exchange accounts. A large quantity of coin disappears annually by being converted into articles useful and ornamental, and it has been impossible to estimate even the approximate amount. Official reports of mining bureaus are seldom accurate, and the mints never receive a very large part of the actual production. Many other causes conspire to make the collection of such statistics very difficult, and the work done by our mint authorities should be appreciated accordingly.

The following table, from *The Bulletin of the American Iron and Steel Association*, gives the most correct figures as yet issued by the mint:

Countries.	Gold.	Silver.
United States	$39,500,000	$64,000,000
Australasia	41,760,800	23,367,700
Mexico	4,500,000	60,817,300
Russia	24,133,400	356,600
Germany	1,498,900	8,240,100
Austria Hungary	1,684,800	2,548,400
Sweden	62,500	119,200
Norway	.....	195,500
Italy	117,000	1,200,500
Spain	.....	2,643,400
Greece	.....	1,472,700
Turkey	8,000	63,000
France	185,300	4,076,100
Great Britain	65,800	329,700
Dominion of Canada	1,042,100	1,096,000
Argentine Republic	95,000	1,551,600
Colombia	2,892,800	2,182,400
Bolivia	67,000	28,444,400
Ecuador	68,400	10,000
Chili	464,400	3,685,500
Brazil	2,219,500	.....
Venezuela	851,600	.....
Guiana (British)	2,310,100	.....
Guiana (Dutch)	650,800	.....
Guiana (French)	1,329,200	.....
Peru	74,400	4,474,800
Uruguay	141,600	.....
Cent. Am. States	470,500	2,000,000
Japan	489,800	2,529,700
China	8,556,800	.....
Africa	40,271,000	.....
India (British)	3,986,900	.....
Corea	467,200	.....
Total, 1894	$179,965,600	$215,404,600
Total, 1893	157,297,000	213,547,800

It will be noticed that, though we have passed through a period of industrial stagnation, the total precious metal production is on the increase, and is liable to continue so.

Equipment of Mining and Metallurgical Laboratories.

THERE has been a long struggle in the lines of technical education in the effort to coördinate the teaching of theory with its practical application. The results of these efforts are seen in our manual training schools, electrical testing laboratories, mechanical laboratories, and numerous mining laboratories. In mining and metallurgy the need for practical experiments conducted systematically has long been apparent. The main point of difference in opinion lay in the extent to which such experiments should be carried, and as to whether they should be illustrative or intended to duplicate actual practice with full-size apparatus. Both these practices have their adherents, though the latest orders from such schools indicate that the mean between models and full-size machinery—*i. e.*, the smallest size found to be efficient in practice—seems to be the size adopted. Prof. H. O. Hofman read a paper at the March meeting of the American Institute of Mining Engineers, under the above title. He introduces his remarks as follows: "The mining and metallurgical laboratory, as we understand the term in this country, is a place in which mechanical and chemical working-tests are made on ores, fuels, and furnace materials. It is of quite recent origin. The first laboratory of this kind to be used in connection with teaching was put into operation in 1871 at the Massachusetts Institute of Technology. . . . Private laboratories for making tests upon ores had previously existed here and there, especially on the Pacific coast, for silver and gold ores; but in the educational field the Massachusetts Institute of Technology was the pioneer. To-day there is hardly a school of mines in this country that has not a more or less complete mining and metallurgical laboratory. In European mining schools there is very little laboratory-teaching. Most of them are located in mining districts, where the students can personally see and engage in the practical work of mining, concentrating, and smelting." Speaking of one-sided instruction, the author continues: "The instructor is liable to give most, if not all, of his time to elaborating unnecessary details of the local methods, past as well as present, and to pass over with amazing celerity those branches of the subject not represented in his district. Yet, even as regards local work, upon which he puts such undue stress, he is likely to be too theoretical, because, not being practically engaged in it, or able to apply such tests as are furnished in the laboratory, he necessarily falls into too abstract a way of viewing the whole subject. The result is that his instruction tends to produce theorists who speak with unwarranted assurance concerning the most difficult problems the engineer has to solve, but who, if confronted with a simple, concrete ques-

tion, are at a loss what to do. That this lack of laboratory-training in German technical schools (which are among the foremost in Europe) is beginning to be realized as a defect was evidenced by the intense interest and careful study bestowed upon the subject by the commissioners who came to the Columbian Exposition 2 years ago. They did not hesitate to praise our system, and to express the hope that it might be adapted to meet their necessities on the other side of the Atlantic." Referring to large plants and mines as an impracticable adjunct to an engineering school, he continues: "The practical study of mining, in this country at least, is carried on to-day in 'summer schools.' The students spend some time in mines, going systematically through the different kinds of work and thus becoming sufficiently familiar with mine-operations to listen understandingly to lectures on the subject. It is the merit of Prof. H. S. Munroe of Columbia College to have given to the summer school of mining such an impetus that to-day there is hardly an American mining school without this auxiliary course." The equipment of the laboratory he introduces thus: "A commercial concentrating works must treat daily a considerable quantity of ore and must work cheaply, which can only be done if the machines are so connected with one another that the ore shall receive a minimum amount of handling after the work is once under way. In the laboratory, on the other hand, the work, being purely experimental, must be carried on step by step, in a deliberate and tentative way; and it is therefore essential that the operator shall be able to inspect the material under treatment before and after every operation. Consequently the machines must be separate, that they may be easily accessible for starting, stopping, accelerating, and retarding, and may be connected at will,—in short, that the work may be modified indefinitely under the immediate eye of the experimenter. A laboratory in which this principle is neglected carries in it the germ of failure." Then follows a detailed description, with observations and drawings, of the plant at the Massachusetts Institute of Technology, and the paper, after giving the price of such a plant and the number of hours devoted to experiments, concludes with the statement that, "while the student does not handle every apparatus, he sees most of them in operation. Every Saturday each student makes, before the assembled class, an oral report of his laboratory work during the past week, and its continuation for the coming one is discussed and laid out."

Consulting Engineers.

THE *Mining Journal and Commercial Gazette*, London (Aug. 24), in bemoaning the lack of appreciation of mining engineers by directors, says: "To us it seems as absurd to try to run a mining business without a technical adviser as it would be to run a ship without a captain. In fine weather and an open sea the captain is to some extent ornamental, but there is no telling when his presence may be of the utmost importance to all concerned. So also with the engineer; it may happen that for weeks together all will go well without him, but then a crisis suddenly arises, and, if he is not on the spot, and well up in his work, a catastrophe will, in all probability, happen, in proportion to which his retaining fee sinks into insignificance." This is a clear statement of the case, and many promising claims have failed because some friend's friend thought a superintendent's berth would fit him, while the "theoretical" engineer of wide knowledge and experience was simply ignored.

Crystallization of Iron.

IT is well known that slow cooling of any highly-heated mass promotes crystallization; the slower the cooling, the larger and more perfect the crystallization. Mr. Thomas Andrews, F. R. S., according to *Invention* (Aug. 17), has applied this principle in obtaining material for his miscroscopical examinations of the structure of wrought iron, using powers from three hundred to two thousand diameters, and ascertained the following peculiarities: "Large masses of iron, several tons in weight of practically pure

wrought iron, were allowed to cool slowly from a white heat. In the process of cooling, the crystallization of the metallic iron occurred. The usual crystals of iron—those which have heretofore been regarded as constituting the ultimate structure of the metal—were found to enclose a sub-crystalline formation consisting of exceedingly small crystals of pure iron, with all the characteristics of the regular order of crystallization. Sometimes these secondary crystals took the hexagonal or six-sided form, the developed angle being about 120 deg., while sometimes they assumed the form of several cubes [probably rhombohedrons.—ED.] The secondary crystals were contained within the area of the larger primary crystals. The markings of the intercrystalline spaces, or junctions of the secondary crystals, were, however, clearly defined, although exceedingly minute. The dimensions of the primary crystals would average about 0.01, the dimensions of the secondary crystals averaging about 0.001. Estimating from the indications of the average microscopical measurement, there must be about one billion of the secondary crystals to the cubic inch of metallic iron. . . . . The mass of metallic iron, on cooling, having reached the crystallizing point, about 740 deg. C., the skeletons of the larger or primary crystals were then formed; as the period of cooling, however, was very slow, the semi-fluid or viscous metal in the interior of these primary crystals seemed, as the process of crystallization progressed, to break up and become divided into a large number of smaller crystals enclosed in the mass of the larger or primary crystals, which had first begun to form. In the course of further experiments on the cooling of large masses of wrought iron, Mr. Andrews also found, by the use of powerful objectives, that these secondary crystals sometimes enclose still more minute forms of crystals of pure iron in the shape of cubes. These may be regarded as constituting a third system of crystallization in pure metallic iron. The experiments further indicate that large masses of heated wrought iron, on cooling from above the temperature of the crystallization of wrought iron,—namely, 740 deg. C.,—are capable of crystallization in three distinct modifications, which may be tentatively called the primary, secondary, and tertiary systems of crystallization in iron, these various modifications being all connected with a regular system of crystallization. . . . . The examinations were made on carefully prepared and polished samples etched with nitric acid and by the use of high microscopic powers. In each case the etching was prolonged under constant observation with lenses, giving time enough to develop the accurate structure of the metal. We have no doubt but that the same or similar modifications of metallic crystallization will be observed in any metal which is slowly cooled, the large crystals forming the skeleton which encloses one or more systems of smaller crystallizations." These observations were made on forgings of practically pure iron about 10 ft. long and 12 in. square, cooling from a white heat.

A Belgian Briquette Plant.

OWING to the interest now shown in the utilization of coal waste, an article contributed to the *Colliery Guardian* (Aug. 9) will be of great interest, showing as it does the arrangement in plan and elevation of a Belgian plant now in operation, and illustrating at the same time the ovoid *boulet* press and the briquette press. The unscreened coal is passed over a cylindrical screen, which separates it into three sizes,—2.75 in., 1.5 in., and 1 in. in diameter. The smaller size is delivered by a bucket chain elevator to a shaking screen, which separates it into three sizes,—0.5 in. and 0.25 in. diameter, and dust, the two former going to a washing apparatus and the dust to a storage bin. After draining, the coal is delivered into a large hopper, sometimes with the coal dust from the bin, as required, and thence drawn into a measuring apparatus where from 5 to 10 per cent. of pitch is added and the whole taken by a conveyor to a Carr disintegrator, thence to a pug mill mixer, where the pitch is softened by steam, and then discharged into two distributors,—one to the *boulet* press, the other to the briquette press.

The presses used are described in the article. It is contended that the *ovoid* form of patent fuel, which requires but little care in manufacture, is preferable to the briquette for domestic purposes, while it may be simply tipped into the holds of vessels without suffering deterioration. There is no reason why such artificial fuels should not replace our expensive cannel coals, especially as their rapid or slow burning can be regulated in the mixture.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Technical Journals—See Introductory.

Metallurgy.

*717. Metallic Alloys (Copper-tin; copper zinc; aluminum copper; chrome-zinc). Col Guard-Aug. 2. 600 w.

*718. Iron-Puddling in Upper Silesia, with Description of a New Gas-Fired Furnace. Ill. Abstract paper by Alexander Gouvy. Col Guard-Aug. 2. 1200 w.

*742. Losses of Gold in Victorian Gold Mining (Editorial. Percentage statistics). Min Jour-Aug. 3. 1500 w.

745. Separation and Treatment of Lead Matte at the Blast Furnace. L. S. Austin (Different taps and modes of separation). Eng & Min Jour-Aug. 10. 2200 w.

746. The Anaconda Hot Air Reverberatory Furnaces. Ill. (With sections). Eng & Min Jour-Aug. 10. 250 w.

757. The South Wales Tin Plate Manufacture (Consular report). Am Mfr & Ir Wld-Aug. 9. 600 w.

759. Blast Furnaces, Aug. 1, 1895 (Statistics). Am Mfr & Ir Wld-Aug. 9. 500 w.

†775. The Physics of Cast Iron (Communications in discussion of the paper of William R. Webster). Tr Am Inst Min Eng-Aug. 10000 w.

†777. The Determination of Graphite in Pig Iron. P. W. Shimer (The purpose of this note is to call attention to a source of error in the determination of graphitic carbon, made by the usual method of solution in hydrochloric acid). Tr Am Inst Min Eng-Aug. 1000 w.

†778. The Effect of Washing with Water Upon the Silver Chloride in Roasted Ore. Willard S. Morse (A record of the conclusions arrived at in explanation of why the amount of silver chloride in actual practice in the mill, does not agree with the amount shown by laboratory-teachings to be present in the roasted ore). Tr Am Inst Min Eng-Aug. 2000 w.

†780. A Comparison of Recent Phosphorus-Determinations in Steel. George E. Thackeray (Difficulties encountered in determining the phosphorus content of material in a manner satisfactory to both seller and buyer). Tr Am Inst Min Eng-Aug. 8800 w.

783. Malleable Cast Iron Ill. (Its manufacture and its properties. A paper read before the Am. Soc. Civ. Eng). Ir Age-Aug. 15. 4200 w.

*829. Recent American Methods and Appliances Employed in the Metallurgy of Copper, Lead, Gold and Silver. James Douglas. Jour Soc of Arts-Aug. 9. 700 w.

853. Notes on Magnetite. William B. Phillips (What magnetite really is; how it may be produced; influence exerted. Results of some experiments). Eng & Min Jour-Aug. 17. Serial. 1st part. 1000 w.

*935. Mossend and Summerlee Iron and Steel Works (Descriptive of a fully up to date, large and important English plant). Engng-Aug. 16. 3300 w.

943. Chemistry in a Car-Wheel Foundry. Asa W. Whitney (From the discussion of the paper of William R. Webster, on "The Physics of Cast Iron." Experiments with mixtures with results). Ir Tr Rev-Aug. 22. 3000 w.

988. The Hardening of Steel. Henry M. Howe (Explanation of the carbon theory and the allotropic theory, with reasons and discussion of the principles). Eng & Min Jour-Aug. 24. 2800 w.

*996. Micrographic Analysis. W. C. Roberts-Austin (Microscopic analysis of steel and other metals, and the methods). Nature-Aug. 15. 2200 w.

1024. Determination of Carbon in Iron—Peiper's Graphical Method (Description with precautions. Consists in rubbing solid sample on porcelain, removing the iron with cupric-ammonium chloride and comparing the carbon with those made by styles of known composition). Ir. Age-Aug. 29. 1300 w.

*1041. Crystallization of Iron. Facts observed by Thomas Andrews (Iron crystallizing at 740 deg. C. contains small hexagonal crystals within the large crystals, and these contain still other smaller ones). Inv-Aug. 17. 700 w.

1090. The Treatment of Zinc-Lead Sulphides. Ill. F. Hille (A short description of a concentrating plant near Freiberg, Saxony). Eng & Min Jour-Aug 31. 1000 w.

*1095. The Thermo Chemistry of the Bessemer Process. Abstract of Prof. Hartley's paper (A thoroughly scientific article with references). Ir & Coal Tr Rev-Aug. 23. 7000 w.

*1096. The Hardening of Steel. Abstract of paper by Henry Marion Howe (Discussion of the various effects accompanying heating and quenching; tables. Read before Ir. & St. Inst). Ir & Coal Tr Rev-Aug. 23. 2600 w.

*1097. The Production of Iron by a New Process. R. A. Hadfield (Effect of aluminum as a reducer of iron oxide). Ir & Coal Tr Rev-Aug. 23. 4200 w.

*1098. A New Method for the Analysis of Chrome Ore and Ferro-Chromium. E. H. Sani-

We supply copies of these articles. See Introductory.

ter (Description of method). Ir & Coal Tr Rev–Aug. 23. 1500 w.

*1099. On Tests of the Physical Properties of Cast Iron. Thos. D. West (Conditions favorable to accuracy). Ir & Coal Tr Rev–Aug. 23. 3000 w.

*1100. The Direct Puddling of Iron in Belgium. Emile Bonehill (Description of process with discussion). Min Jour–Aug. 24. 2700 w.

1101. Malleable Cast Iron.—Its Manufacture and Its Properties. H. R. Stanford (Read before the Am. Soc. of Civ. Eng. Containing illustrations of melting and annealing furnaces and practical details). Ry Rev–Aug. 31. 4500 w.

*1191. On the Direct Puddling of Iron. Ill. Emile Bonehill (Paper read before the Iron and Steel Inst. Illustrated by three views of the furnace used). Ir & St Tr Jour–Aug. 24. 1800 w.

*1199. The Ironworks of the South of Russia. George Kamensky (Valuable information with statistics of this little known country). Iron–Aug. 24. 5000 w.

*1200. Nickel Steel and Its Advantages over Ordinary Steel. Henry Wiggin (A short paper with an interesting discussion by Mr. James Riley and others). Irm–Aug. 24. 11000 w.

*1201. Small Cast Steel Ingots. R. Smith-Casson (Illustrated description of method of filling the multiple molds from below). Irm–Aug. 24. 3300 w.

*1202. Cooling Curves and Tests for Cast Iron. W. J. Keep (A valuable illustrated paper by an authority on the subject). Iron–Aug. 24. 4400 w.

*1226. Dry Crushing and Cyanide. W. Franklin White, in So. African Jour. (Results of experiments on dry crushed pyritic ore. Abstract). Aust Min Stand–July 20. 2200 w.

*1228. Cyanide Practice. Alfred James (A paper read before the Inst. of Min. & Met. dealing with samples, plant and extraction. Description of process). Aust Min Stand–July 27. 1500 w.

*1263. The Manufacture of Tin Plates in Germany (From U. S. Consular Report on the practice at Chemnitz, Cologne, Dusseldorf and Frankfort, with description in detail of process employed). Ir & Coal Tr Rev–Aug. 30. 5400 w.

Mining.

23. Anaconda Copper Mining Company (Brief history; description of property; company reorganization). Ill. West Min Wld–July 6. 500 w.

24. New Mining Laws (Digest new Montana code). West Min Wld–July 6. 1100 w.

28. Appreciation of Copper Stocks (Editorial. Prices in 1894 and 95 compared). Eng & Min Jour–July 6. 1200 w.

*689. Electricity in Bituminous Coal Mining. R. M. Haseltine (Valuable tests of electric mining machines). Eng May–Oct. 4000 w.

*711. The Phosphate Deposits of Florida (District; mining costs; prices phosphate). Ill. Engng, Lond–Aug. 2. 3000 w.

*715. The Right of Surface Support in Connection with Mining (English legal rulings: comments). Col Guard–Aug. 2. 3500 w.

*716. Distribution of Power in Collieries. Llewelyn B. Atkinson (Abstract of paper read at the So. Wales Inst. of Eng). Col Guard–Aug. 2. 3000 w.

*727. The Emery Deposits of Naxos (Report of British Consul; occurrence; quarrying methods). Ir & Coal Tr Rev–Aug. 2. 2200 w.

*738. Colorado Marble. Ill. Arthur Lakes (Geological; utilization). Stone–Aug. 2000 w.

*741. Notes from Andalucia. William Guthrie Bowie (Copper pyrites deposits). Min Jour–Aug. 3. Serial. 1st part. 6000 w.

743. Calumet and Hecla Mining Company, Michigan (With editorial comments). Eng & Min Jour–Aug. 10. 1200 w.

758. Illuminants Used in Mines (Report of paper by A. H. Stokes; kerosene tests). Am Mfr & Ir Wld–Aug. 9. 900 w.

797. Gold-Mining in Alabama. H. S. Fleming (Prospects for fairly profitable operations). Mfrs Rec–Aug. 16. 1900 w.

798. The Trouble with Our Southern Gold Mines. Courtenay De Kalb (A chronicle of disasters and their causes; how to dispel the prejudices of the past). Mfrs Rec–Aug. 16. 2000 w.

*851. Mineral Statistics of New South Wales—The Gold Output (Editorial on report of the Department of Mines and Agriculture of New South Wales for 1894). Min Jour–Aug. 10. 1800 w.

852. The Coal and Other Mines of Ohio in 1894 (Abstract of report of R. M. Haselton, Chief Inspector of Mines of the State of Ohio). Eng & Min Jour–Aug. 17. 1300 w.

*866. The Dargo High Plains Gold Field (Vic.) (Interesting story of Alpine prospecting). Aust Min Stand–July 13. Serial. 1st part. 2200 w.

*875. The Hirschberg Lignite Deposits in Hesse, with Particulars of the Marie Mine. A. Vthemann, with additional particulars by Dr. Mohs. Ill. Col Guard–Aug. 9. 3700 w.

*923. Electricity in Mining Work. T. B. A. Clarke (An examination of the general conditions which limit the use of electricity in mines). Elec Eng, Lond–Aug. 16. Serial. 1st part. 1700 w.

*928. Diminished Use of Explosives in Belgian Collieries. Victor Watteyne (From a report dated July 9, 1895). Col Guard–Aug. 16. 2200 w.

953. The Manitoba Coal Fields (Localities, history, prices and production since in 1887). Am Mfr & Ir Wld–Aug. 23. 700 w.

980. Compressed Air Locomotives. Ill. (Discussion and description. Advantages for mining purposes). Age of St–Aug. 24. 500 w.

989. The Essen Coal Company's Electric Mining Plant. Ill. Timothy W. Sprague (Descriptive). Eng & Min Jour–Aug. 24. 1700 w.

1005. The Silverton Electric Plant (Description of a three-phase system electric plant, with its advantages over steam power formerly used. Designed to furnish power for the Silverton,

Col., group of mines). Min Ind & Rev–Aug. 22. 1000 w.

1008. The New Aspen Plan (A co-operative leasing system of working silver mines, based on richness of ore). W Min Wld–Aug. 24. 800 w.

*1042. Coal Mining in Servia (Brief description of some of the working collieries with their production in 1894). Ir & St Tr Jour–Aug. 17. 1300 w.

1091. The Silver District of Tehuilotepec, State of Guerrero, Mexico. Edward Halse (Descriptive). Eng & Min Jour–Aug. 31. 3000 w.

1092. Sampling Gold Quartz (Information for prospectors. Pocket balance with table of values and fineness). Min & Sci Press–Aug. 24. 900 w.

*1117. Roth's Method of Firing Mine Shots. Ill. Richard Cremer (Exploding a charge by means of chemical action in preference to a fuse). Col Guard–Aug. 23. 2300 w.

*1118. Water Power Applied by Electricity to Coal Dredging. Robert Hay (Owing to expensive fuel, an electric plant run by a Pelton wheel was installed to furnish power for the dredge). Col Guard–Aug. 23. 1700 w.

*1120. The Magnesite Ore Deposits of Greece (Description with analysis). Col Guard–Aug. 23. 600 w.

1158. The Great Gunnison Gold Belt. Ill. Dean Burgess (Observations on various mining camps and claims in the district, with map and view of the city of Gunnison). Min Ind & Rev–Aug. 29. 2600 w.

*1227. The Broken-Hill Proprietary Mine (Review of the official report). Aust Min Stand–July 27. 1200 w.

*1229. Tin Mining in the Malay Peninsula. Interview with W. Straughan (Description of the general conditions existing at the tin mines). Aust Min Stand–July 27. 1000 w.

*1230. Australian Broken Hill Consols Mine (Description of interesting prospecting work). Aust Min Stand–Aug. 3. 900 w.

1233. The Deadwood Placer Claims, Idaho. Ill. Walter Hovey Hill (Brief description). Eng & Min Jour–Sept. 7. 600 w.

*1239 Loss of Head in Air Currents Traversing Underground Workings. Ill. M. D. Murgue (Abstract of paper read before the Chicago Eng. Congress. Experiments showing the advisability of regulating the character of air passages as to friction and contracted areas in preference to increasing blowing capacity). Eng, Lond–Aug. 30. 1000 w.

*1251. Transmission of Power by Electricity (Discussion following the reading of papers,—"Electrical Haulage at Earnock Colliery," by Robert Robertson, and "Water-power Applied by Electricity to Gold Dredging," by Robert Hay). Col Guard–Aug. 30. 7500 w.

*1252. Prospecting for Placer Gold—A Novel and Gigantic Scheme in Clear Creek Canyon, Col. Ill. (A scheme to work the placer deposits in the creek bottom by means of converging the stream on certain points and collecting the gold sand in the usual manner). Col Eng–Sept. 2000 w.

*1253. Coal-Washing. Ill. J. J. Ormsbee, in Trans. Am. Inst. of Min. Eng. (Description of a 400-ton Robinson washer, having an upward current sufficient to carry the coal over and let the heavy matter sink to the bottom of the funnel. The cost and efficiency is fully discussed). Col Eng–Sept. 3800 w.

*1254. Mine Haulage. Ill. (Description of a 18,500 lb. compressed air mine locomotive, working under 600 lb. pressure, with 7×14 cylinders and 36 in. gauge. In use at Glen Lyon, Luzerne Co., Pa., Coal Mine). Col Guard–Sept. 800 w.

*1255. A "Prison" Mine (A sketch of prison life at an Alabama mine, worked by convicts. The sanitary conditions are good, a hospital being included. Up to 4 tons coal required per day per man; all over the required quantity is paid for at the usual rate. Prisoners are not isolated). Col Guard–Sept. 1600 w.

*1259. Cinnabar in Texas. William P. Blake (A paper contributed to the Am. Inst. of Min. Eng. Description of outcrop. Conditions for working are difficult and very little work has been done). Min Jour–Aug. 31. 3000 w.

*1260. Wet vs. Dry Crushing of Gold Ores (Short abstract of principles involved). Min Jour–Aug. 31. 2200 w.

1265. Improvements in Water Spraying Apparatus for Damping Dust in Mines (Experiments with eleven burners and sprays with a description of system employed at the Great Western Colleries, England, with discussion). Can Min Rev–Aug. 2000 w.

1267. Mining Explosives. Vivian B. Lewes (Discussion of three classes of explosives. Class I. Gunpowder. II. The nitroglycerines. III. Westphalite, carbonite, etc., relative to safety, health of miners, etc). Can Min Rev–Aug. 3200 w.

Miscellany.

*739. Measurement of Stone. F. C. Neeb (Differences between quarry and contractor). Stone–Aug. 900 w.

*740. The Alabaster Industry (From report of Vice-Consul Carmichael on Volterra quarries). Stone–Aug. 2900 w.

†774. The Equipment of Mining and Metallurgical Laboratories. Ill. H. O. Hofman (Account of the origin of such laboratories; equipment; cost). Tr Am Inst Min Eng–Aug. 11500 w.

†776. Onyx Marbles. Courtenay DeKalb (Notes, partly the result of individual investigation, partly of information from engineers and others, and partly of research in literature). Tr Am Inst Min Eng–Aug. 4500 w.

†779. The Form of Fissure-Walls, as Affected by Sub-Fissuring, and by the Flow of Rocks. William Glenn (A geological study). Tr Am Inst Min Eng–Aug. 5800 w.

†781. Folds and Faults in Pennsylvania Anthracite Beds. Ill. Benjamin Smith Lyman (Geological). Tr Am Inst Min Eng–Aug. 3000 w.

854. Quarrying. Ill. C. Le Neve Foster (Abstract of lecture,—practical in character,—delivered before the Sanitary Inst., London, Eng). Eng & Min Jour–Aug. 17. 2400 w.

855. Cement Materials in Iowa. E. H. Lonsdale (Abstract of paper read before the Iowa Academy of Sciences). Eng & Min Jour–Aug. 17. 700 w.

*876. A Belgian Briquette Plant. Ill. (Plan and sectional elevation, with the details of briquette and boulet presses, illustrating the screening, washing and patent fuel plant made by the Société Anonyme des Forges, near Charleroi). Col Guard–Aug. 9. 800 w.

880. The Phosphate Industry. Ill. (Statistics). Tradesman–Aug. 15. 700 w.

881. Bauxites of Georgia and Alabama. William M. Brewer (Metallurgy and uses of aluminum. Extent of deposits and use of Bauxite ore). Tradesman–Aug. 15. 4000 w.

*926. Water Power Applied by Electricity to Gold Dredging. Robert Hay (The plant described is the first of its kind constructed in New Zealand). Ind & Ir–Aug. 16. 1800 w.

*929. The Employment of Horses in Collieries. M. Boissier (Abstract of paper read at meeting of the Société de l'Industrie Minérale of France). Col Guard–Aug. 16. 900 w.

*930. New Scheme for Unwatering the Staffordshire Coalfield (An important work demonstrating the manner in which science can cope with coal-mining difficulties). Col Guard–Aug. 16. 1200 w.

950. California's Iron Ore Deposits (Localities and analysis). Am Mfr & Ir Wld–Aug. 23. 1200 w.

954. Iron Ore in Pennsylvania, New York and New Jersey (Production of various varieties). Am Mfr & Ir Wld–Aug. 23. 800 w.

955. Coke Production in 1894 (Editorial, containing production statistics by states) Am Mfr & Ir Wld–Aug. 23. 300 w.

*957. Mineral Statistics of New South Wales (Editorial. Production statistics). Min Jour–Aug. 17. 1800 w.

1006. Coal Production in 1894 (Abstract of report of the U. S. Geol. Surv. by E. M. Parker. Description of coal fields with their production). Min Ind & Rev–Aug. 22. 1600 w.

1007. Suggestions as to Building a Mill (Practical hints and precautions drawn from experience). West Min Wld–Aug. 24. 800 w.

1023. Annealing Armor Plates by Electricity. Ill. W. W. Hanscom, in the Pacific Electrician (The Harveyized face of these plates, being too hard to be drilled, were annealed by heating locally with a maximum current of 6000 amperes at four volts. Description). Ir Age–Aug. 29. 800 w.

†1031. Stratigraphy of the Kansas Coal Measures. Charles Rollin Keyes. Am Jour of Sci–Sept. 1900 w.

†1032. Native Sulphur in Michigan. W. H. Sherzer (Description of deposits). Am Jour of Sci–Sept. 1100 w.

*1076. Prevention of Accidents in Mines. Austin Kirkup (Abstract of paper read before the Federated Institute of Mining Engineers on accidents due to explosives and roof-falls). Ind & Ir–Aug. 23. 6800 w.

1093. Oregon's Gold Beaches. From report of H. V. Winchell and F. F. Sharpless (Character of the deposits). Min & Sci Pr–Aug. 24. 1200 w.

*1119. The Mineral Resources of South Staffordshire. Herbert W. Hughes (Read before Ir. & St. Inst. Occurrence of various substances with their present development and the output of coal and iron stone). Col Guard–Aug. 23. 5000 w.

1122. The Coal Fields of Manitoba (Brief description, with prices and production since 1887). Am Gas Lgt Jour–Sept. 2. 600 w.

†1142. Asphalts and Bitumens. Samuel P. Sadtler (A general lecture giving localities, analyses and uses). Jour Fr Inst–Sept. 4200 w.

1157. The Granite City Basic Steel Works. Ill. (Description and plan of works). Ir Age–Sept. 5. 1500 w.

1232. The Elective System as Adopted in the Michigan Mining School. M. E. Wadsworth (Advantages as compared with fixed courses). Eng & Min Jour–Sept. 7. 1600 w.

1240. Mineral Products of the United States (The quantity and value of fifty-four mineral and metallic substances produced in the United States, since 1889, yearly. The total value for 1894 was $527,655,562. The value in 1893 being $574,201,807). Mfrs' Rec–Sept. 6. Table.

*1249. The Geological Survey of England and Wales (A report by Archibald Geikie on progress of the survey. Four out of the thirteen sheets of the map of England and Wales is published. The South Wales and North Staffordshire coal areas have received considerable attention). Col Guard–Aug. 30. 6500 w.

*1250. Pumice Stone Mining (The analysis of pumice gives silica 73.7 per cent. and alumina 12.27 per cent. Abstract of report on the pumice stone industries of the Lipari islands. It is found in caves and by tunnelling, requiring a total of about 1000 hands). Col Guard–Aug. 30. 900 w.

*1264. The Production and Consumption of Iron Ores (Comparison of the production and character of ores in Great Britain, United States, Germany, France, Belgium, Sweden, Italy, and Austria). Ir & Coal Tr Rev–Aug. 30. 1300 w.

1266. Rock Drills (A discussion of the relative merits of ×, +, and Z bits, with many practical suggestions on the operation of the drills. From the catalogue of the Ingersoll-Sergeant Rock Drill Co). Can Min Rev–Aug. 3500 w.

1279 Mine Development the Basis of Great Prosperity. Almarin B. Paul (A general letter discussing the business situation and the outlook for mining). Min & Sci Pr–Aug. 31. 3000 w.

*1293. The "Boom" in Mining Shares (Economically considered). Bank's Mag, Lond–Sept. 5000 w.

MUNICIPAL ENGINEERING

Street Subways for Large Towns.

A PAPER of value was read recently by Mr. Charles Mason before the Society of Engineers, Manchester, Eng., an abstract of which appeared in *The Gas Engineer's Magazine*. The author first criticises the old-fashioned way of laying underground pipes, in which periodical inspection of the mains for "ascertaining their condition or for stopping leakages is almost impossible." Especially is this the case with gas and electric mains, "and recent explosions in London and other cities" have rendered it a duty to adopt a better system, whereby material of whatever nature laid underground can be easily examined from time to time. The construction of subways is the most satisfactory and, in fact, the only method of so laying pipes and mains that these conditions can be complied with. The frequent disturbance of pavements, now so great an inconvenience, could be largely avoided by the use of subways. In fact, nothing could be more unsatisfactory than the present system, although the author is free to admit that any remedy is attended with many difficulties unknown to the ordinary observer. It is now almost an axiom in building that "no pipe must be out of sight," and any one erecting a house and burying the supply of waste-pipes in brickwork or plaster, or by other means making them inaccessible, is looked upon somewhat as a "jerry builder." The same law should apply to the streets, for what is lost to the holder in case of a desired examination for an escape is also lost to the ratepayers in examining an underground main. Undetected leakages may also—and often do—exist for long periods, some one suffering thereby, as for example: (1) the householder, in the case of a leakage from the water main into the basement; (2) the water company, from loss of water; (3) the gas company, from losing gas, as the condition of the subsoil of streets freely proves; (4) the public generally, from risks incurred in using the streets.

The design of a subway involves the following considerations: (1) the number and size of mains likely to be laid in at the time it is constructed and in future time; (2) ample space for workmen; (3) placing pipes in such manner as to afford facilities for repairs and connections; (4) provision for sewer inspection and ventilation; (5) provision of light and ventilation for the subway proper; (6) planning to avoid crossing the subway service pipes; (7) provision for proper fall of gas and water pipes; (8) water-tight overhead construction; (9) provision for street appliances and fixtures, such as lamps, fire hydrants, etc.

The author describes a scheme for a subway design which is intended to meet all the above requirements, of which scheme the following is an outline.

A triple subway is to have a central avenue for the trunk mains and sewer, and subsidiary or supply subways on either side for the smaller pipes from which are taken the house connections. The central avenue is 10 ft. wide by 6 ft. 3 in. high, with a segmental arch over, the subsidiary subways being 6 ft. wide by 6 ft. high. The whole is constructed in cement concrete, with brick arches and glazed brick facings throughout. Vaults are provided beneath the footways, which should be the property of the authorities and leased to adjoining occupiers. The author makes a strong point of this, as in many cases the fact that the vault construction is private property prevents the public authorities from making satisfactory repairs to the footpath. A tramway is provided in the central subway for carrying materials. The public sewer is placed beneath, with manholes at stated intervals, the house drains passing from the inspection "areas" in the vaults to the sewer in the ordinary manner. Gulleys are provided in the floor of the subway to receive washings, and for the discharging of the water mains.

The street gulleys to are be placed over spandrels formed by the vault construction, piers being built for encasing them where necessary. The outlets from these gulleys are carried down through the subway construction into the sewer, and are also carried up to the footway pavement for inspection and cleansing. An asphalt damp course is laid over the arching, outlets for the drainage thereof being provided at intervals in the springing, and connected therefrom to the sewer below.

The sideways are approached from the central way by arched openings, 4 ft. wide, in the division walls. The whole construction is covered with concrete floated to the contour of the roadway to receive the paving. Light and ventilation are procured by means of overhead gratings opening into the roadway, and special openings for this purpose are provided at regular intervals. The sewers must not be ventilated into the subway; special means are provided for this ventilation by pipes taken from the sewer and carried up to the adjoining buildings, or connected with the external air independently of the subway.

Street lamps and water posts are fixed on the footways over the spandrels of horizontal arches, stoneware pipes being built in from the bases of same to the subsidiary subways for the reception of the gas and water supplies, which can be drawn through these pipes when repairs are required. The large trunk mains rest upon sleeper walls, and the smaller ones are carried upon brackets built into the wall or attached to the overhead arching; these latter carry the telegraph, telephone, and lighter wires. All the pipes are placed at a distance from the wall so as to allow for junctions, valves, and connections; special passages or chases, about 12 in. by 9 in., are left in the vault walls for passing through the services; these passages can be closed by suitable blocks or other means at each end.

Street fire hydrants must be placed in position similarly to the lamp columns, it being essential for them to be readily accessible from the road surfaces. Should it be necessary and desirable to construct electric transformer chambers for the high tension cables, these can be placed in arched openings in the division walls of the subway; but in the author's opinion all transformers should be entirely upon the property of the company owning the same.

Special entrances are to be constructed for the reception of pipes and other materials, and these can be arranged where side streets and courts abut upon the main street in which the subway is placed.

Welsbach Burners at San Jose, Cal.

BEFORE the Pacific Coal Gas Association at its recent meeting Mr. E. C. Randall read a paper recounting his experience with the Welsbach burner in San Jose, Cal. It is evident from this paper that electric lighting has met with a powerful competitor in gas burned in the improved Welsbach burner. Mr. Randall encountered much prejudice and many obstacles in introducing the system. There are "two electric lighting companies" in San Jose, "one operated by the gas company, which was compelled, owing to opposition, to sell its current at a low figure, as the following rates demonstrate: electric arc, 11 to 1 P. M., $1.50 and $2, respectively, per week, with one or more additional incandescents free, as the case might be. Incandescents, 16-c. p., 12 o'clock and all-night circuits, from 15 to 25 cents per week. Gas, $3 per 1000." The low current cost of illumination was not, however, the most formidable obstacle; this was "the financial objection," which was ingeniously overcome by the following proposition. Say the person to be dealt with was Mr. A. "I supplied him with lamps to duplicate his illumination, furnishing sometimes his plumbing and gas fixtures. At the end of each month, after deducting his expenses for gas, the balance was applied as part payment for lamps and fixtures, as the case might be. The results of this proposition as to his earnings have averaged from 60 to 90 days; in a few cases lamps have earned themselves out in one month; in only one case have I been caught."

"The Welsbach light has changed the condition of the illuminating companies in

San Jose. A few years ago the gas company, to protect itself, had to purchase and erect an electric plant, which put it to considerable expense; and, until the Welsbach light was introduced, progress was slow for them. To-day the opposition electric company, to protect its electricity, proposes to build a gas plant. Why? Welsbachs are too much for them. This is the first electric lighting company in the United States to employ gas as a weapon against its own industry."

Mr. Randall asserts his belief "that it is only a question of time when extra distribution and a more economical light will be required and demanded by the taxpayer," and adds that the success of the Welsbach burner for street lighting is by no means an untried or undemonstrated fact. In Europe street lighting is done extensively by this burner. In referring to his own work at San Jose, he states that he has now about forty outside lights, and that the proportion of mantles destroyed has been about the same as with those used for indoor illumination. "The gas manager should feel enthusiastic at the prospects in this field, as a firm fixture is all that is required to protect the mantles from the wind, and they are immediately a success. They can easily be protected from rain, and, with a by-pass (maintaining a small light to preserve heat), from dampness." In conclusion, Mr. Randall expresses entire confidence "in the future of the Welsbach light, if it receives proper attention," and also thinks it absolutely necessary that the gas companies of the Pacific coast act in harmony with the Welsbach Company.

Asphalt Pavements.

MR. CLIFFORD RICHARDSON, in *Paving and Municipal Engineering* for August, says that the life of asphalt pavements depends upon the materials of which they are constructed, the skill with which they are laid, and the amount of traffic to which they are subjected. With traffic of ordinary character, the best materials, and good work in putting it down, an asphalt road should last 15 years. The pavement in front of the Arlington Hotel on Vermont avenue in Washington is cited as an example of such a pavement. If too soft cement is used, the surface soon becomes uneven; if too hard cement is used, the pavement cracks; if too little cement be used, the pavement will crack.

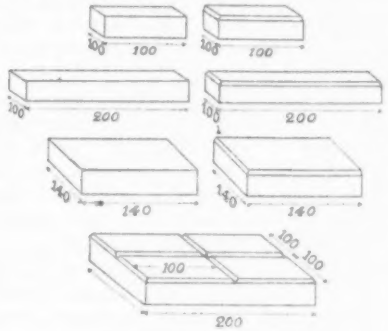
Mr. Richardson also points out "that the best pavements have, in addition, enemies which will destroy them, if not prevented. Water penetrating into the base and surface from the seepage of ground higher than the pavement has an injurious effect; while the escape of illuminating gas from the mains produces a peculiar and characteristic disintegration, which is readily recognized. The success with which asphalt surfaces have been maintained on some of the narrow streets of the lower part of the city of New York, with the very heavy traffic there met with, shows that, with skill in laying, asphalt pavements may be made suitable for even very trying conditions; and, as they have been maintained at such geographical extremes as New England and Louisiana, it would seem that climatic conditions do not qualify their use."

Mr. W. H. Delano, in the same number of the same magazine, writing of natural rock asphalt paving in Paris and other European cities, says it has been found that compressed asphalt is not only the most hygienic, "but also the cheapest mode of pavement; and, now that transit to the suburbs is so cheap, the working classes who pay the greater portion of the 170,000,000 francs' tax ($34,000,000) will no longer live in dear and unhealthy slums.

"Some 20,000,000 francs, or $4,000,000, is to be laid out in drainage works, so as to further reduce the death-rate within the city limits and prepare Paris for the grand exhibition of 1900, of which the buildings alone will cost 100,000,000 francs, or $20,000,000." "Wood is still being laid, but a reaction has set in against it, headed by the doctors. It has been proved to breed the microbes of diphtheria and tetanus. The putrid fibrous dust from an old wood pavement is most deleterious to the eyes and throat."

The forms of compressed asphalt slabs that have been used in Paris are shown in the accompanying engraving. Their pleas-

ing color is said to harmonize well with that of building stone. "They are laid, like glazed tiles, on a Portland cement mortar. The hydraulic press in which they are made is fitted with an accumulator. There are two pistons, giving two successive pressures, on a revolved platform; the unmolding is effected simultaneously. The powder is heated on a kiln alongside the



ASPHALT SLABS. PARIS.

press. The powder is heated just as if for a street pavement."

But Berlin ranks foremost in the use of natural compressed asphalt. It has over 1,200,000 sq. yds., about as much as in Paris and London together. A brief description and an engraving of a compressing plant for manufacturing asphalt blocks are given in Mr. Delano's article.

Sanitary Pavements.

THE *Engineering Record* (Aug. 24) says editorially that hereafter sanitary qualities will largely influence the choice of city pavements. This will be readily admitted, as this consideration has been growing in importance ever since, and even before, the now almost wholly discarded wood pavement came into use. It now has reached almost the stage of controlling consideration, at least in the better streets. It is certain that a pavement known to be of unsanitary character would have little show of acceptance in the residence districts of any large and well-regulated town. There is stated in this editorial a fact not generally known to citizens of average information,—to wit, that the air over an unsanitary pavement may be contaminated by its exhalations in the same way as air is polluted by the emanations of a stagnant pond. It says: "Recent examinations of the atmosphere in Cleveland, O., as well as considerable work of a similar character in other places, reveal unsanitary conditions of the air to which the street pavements undoubtedly contribute to a very material degree. It is, of course, obvious that the waste gases from chimneys and the vapors thrown off by sewers and in some industrial operations will by their presence directly vitiate the atmosphere, and in some cases they mny be the main sources of vitiation; but, in general, we believe that the known deterioration of the atmosphere in cities is largely produced by the unsanitary condition of the street surfaces.

"The fact has long been known among sanitary engineers that street washings are no improvement in character over ordinary sewage, and occasionally the latter liquid may have the advantage. Single block pavements, as ordinarily laid, are full of openings between the blocks, which persistently hold dirt saturated with the foul liquids of the street, and under the action of the sun the most unwholesome vapors are constantly being discharged into the atmosphere. However well laid such pavements may be, these unsanitary conditions are constantly being created with more or less activity; good work will only to a small extent remedy the evil. During the cold portion of the year these effects are largely mitigated, but not removed, while attacks of diseases peculiar to cold weather find favorable physical conditions of the population induced by the active unsanitary conditions of the preceding hot weather. The continuation of these circumstances year after year extends the foul saturation to the earth under the pavement, and intensifies the polluting effects of the whole mass on the atmosphere."

It is alleged that in many parts of New York city the street paving is unsanitary, and the prevalence of diseases like grippe and pneumonia, which have been almost, if not quite, epidemic at times, may be, in

a great measure, thus accounted for. In conclusion, "an impervious pavement kept clean" is the only street surface that can be called sanitary. Bricks or blocks the joints of which are made tight by an asphalt filling, or an asphalt pavement pure and simple, would meet the necessary conditions.

Specifications for Paving Bricks.

PAVING AND MUNICIPAL ENGINEERING says the best plan is to definitely state the tests to which the sample bricks submitted by different bidders are to be subjected. The specifications should definitely state the maximum and minimum sizes acceptable. The required tests of absorption, transverse strength, abrasion, impact, rattler or tumbling, these and other tests should be minutely described and the requirements stated. It is a well known fact that some brick manufacturers make several qualities of bricks as well as bricks with several names, which, taken in conjunction with the fact that the products of the same kiln are not always alike, demonstrates at once why definite tests should be named in specifications and not the names of the bricks acceptable to the city. This is done in most materials of engineering and building construction and should, without doubt, apply to the materials of pavements. Tests should be made before the work is begun and at short intervals during the work.

IN *Paving and Municipal Engineering* for September, Mr. Fred. A. Krummer, C. E., says that while cleanliness is a result apparent since Col. George E. Waring, Jr., has been at the head of the street-cleaning department, the results are yet not all that might be desired. One of the causes for deficiencies which have been removed is the ubiquitous ash-barrel "over-flowing in its exuberance of dirt and refuse, making the condition of the city a most unsanitary one. The department has, however, been greatly hampered in its work by political restrictions, the result of long years of ring bossism, which, in so many cities, hangs like a great millstone around the neck of good government. . . . The ridiculous agitation raised by the Grand Army of the Republic, recommending Colonel Waring's removal from office, has not prevented people from recognizing the value of his work."

THE ENGINEERING INDEX—1895.

Current Leading Articles on Municipal Engineering in the American, English and British Colonial Technical Journals—See Introductory.

*703. The Heating Value of Coal Gas. Ill. David Voss, with Discussion. Read at Asso. of N. British Gas Managers (Dulong's calorimeter and worm calorimeter sufficient and most convenient for determining calorific value of gas). Gas Wld-Aug. 3. 2500 w.

*704. Gas Making from Splint and Shale, and from Splint and Oil Compared. A. Waddell, with Discussion. Read at N. Brit. Asso. Gas Managers (Practical experience). Gas Wld-Aug. 3. 4000 w.

706. Wrinkles. Ill. T. R. Parker, at the Pacific Coast Gas Asso. (Deals with a long list of practical matters relating to gas manufacture). Am Gas Lgt Jour-Aug. 12. 4000 w.

707. One Year's Experience with Welsbach Burners. E. C. Randall, with Discussion highly favorable to their use for street illumination. (Pacific Coast Gas Asso). Am Gas Lgt Jour-Aug. 12. 4200 w.

*719. Hydraulic Stoking Machinery in Gas Works. A. S. Biggart (Progress and present status of this system in a number of the most important English and European cities. Discussion Inst. of Mech. Eng. at Glasgow). Eng, Lond-Aug. 2. 2000 w.

*1003. Installation of Carburetted Water-Gas at Tottenham. A. E. Broadberry (A popular exposition of the differences between water-gas and ordinary coal-gas; the reasons for its adoption at Tottenham, and a description of the installment, alleged to have given great satisfaction). Gas Eng Mag-Aug. 10. 3300 w.

*1082. On the Illuminating Value of the Various Constituents of Coal and Oil Gas and Conditions Necessary to Produce Incandescence. W. Ivison Macadam (Discussion with analyses of London gases). Gas Wld-Aug. 17. 2300 w.

*1235. The Windsor Street Works of the City of Birmingham—Gas Department (Description of plant used. Interesting on account of variety of plans adopted). Eng, Lond-Aug. 30. 2500 w.

1261. A Fuel Gas and Air Mixer (Apparatus for mixing gas with a certain quantity of air before burning. Automatic). Am Mfr & Ir Wld-Sept. 6. 400 w.

1276. Incandescent Gas Lights in Exposed Positions (Relates experience of the engineer of ths Margate Gas Works, as recorded in a systematic series of notes comprising observations on

We supply copies of these articles. See introductory

effect of fogs upon the durability of mantles). Jour of Gas Lgt–Aug. 27. 1000 w.

Sewerage.

*691. Future Methods of Sewage Purification. W. L. Hedenberg (Excellent results of the electric system). Eng–Mag–Oct. 3500 w.

921. The Sewerage System and Sewage Farms of Paris, with Editorial. Ill. (A Comprehensive description of the Paris sewers and sewage farms, both past and future). Eng News–Aug. 22. 8000 w.

933. The Glasgow Sewage Works. Ill. (An exhaustive, detailed description). Engng–Aug. 16. Serial. 1st part. 1500 w.

964. Sewage Disposal at North Brookfield, Mass. Ill. (Detailed description of a system designed primarily to remove factory wastes, the removal of house sewage being a secondary consideration. Eng Rec–Aug. 24. 1100 w.

*1080. Eccles Corporation Sewage Works (Disposal of sewage by plant consisting of settling tanks and irrigation farm). Ill. Eng, Lond–Aug. 23. 1000 w.

1215. Steam Shovels for French Excavation and Backfilling. Ill. (Short description of two self-propelling machines possessing valuable features). Eng News–Sept. 5. 400 w.

1248. Proposed Drainage System for the City of New Orleans (The raising of surface drainage water by pumps, as the surface is below the river high-water mark. Map, profile and section of proposed canal. The cost will approach eight million dollars). R R Gaz–Sept. 6. 1500 w.

Streets and Pavements.

822. Surface Drainage and Natural Water Courses in Boston, Mass. (An instructive abstract of a report by Henry B. Wood, executive engineer of the Street Department). Eng Rec–Aug. 17. 2700 w.

960. Sanitary Pavements (Editorial. Sanitary qualities in pavements will be registered in the future. Why some pavements become and are unsanitary). Eng Rec–Aug. 24. 600 w.

1033. Macadamized Streets. Ernest McCullough (Model specification). Eng & Con–Aug. 23. 1000 w.

*1102. Paving Brick Tests and a Proposed Method of Drawing Specifications. L. C. Sabin (Discussion of two new tests with diagrams). Pav & Mun Eng–Sept. 1400 w.

*1103. How the Streets of New York Are Cleaned. Fred. A. Kummer (Description of the organization and work of the street cleaning department). Pav & Mun Eng–Sept. 1700 w.

1210. Asphalt Pavements as a Problem in Engineering. S. F. Peckham (Interesting information and details). Eng News–Sept 5. 1900 w.

1212. Backfilling Trenches in Streets. S. Whinery, with Editorial (Discussion of best practice). Eng News–Sept. 5. 2700 w.

Water Supply.

801. Report on Defects in the Queen Lane Reservoir, Philadelphia (Results of an examination by John C. Trautwine, Chief of the Phila. Bureau of Water, Rudolph Hering, and Maj. C. W. Raymond, U. S. A. All members of the Am Soc. C. E. $250,000 is the estimate for needed repairs). Eng News–Aug 15. 2000 w.

803. Flood Overflow of the Sweetwater Dam. Ill. H. N. Savage (Location; plans for reconstruction). Eng News–Aug. 15. 1200 w.

805. A Water Supply for Jersey City (Plans; specifications, etc). Ill. R R Gaz–Aug 16. 1200 w.

961. Scraping Small Water Pipes (A new device for cleaning foul and obstructed water pipes). Eng Rec–Aug. 24. 500 w.

963. The New Croton Aqueduct and Storage System. Ill. (History and detailed description). Eng Rec–Aug. 24. Serial. 1st part. 3300 w.

1084. Washington's Water Supply. Ill. (General description). Fire & Water–Aug. 31. 1100 w.

*1106. Filtration of Municipal Water Supplies. George H. Elliot (Description with method of removing bacteria). Pav & Mun Eng–Sept. 1300 w.

1206. Removal of Iron from Ground Water at Charlottenburg (Method of removing iron from water to prevent clogging of filtersin water supply plants). Eng News–Sept. 5. 400 w.

1207. The New High Service Water Supply of Manchester, N. H. Ill. (Brief description of new works). Eng News–Sept. 5. 700 w.

1213. The Elevated Water Tank at Fairhaven, Mass. Ill. (Detailed description and detail drawings). Eng News–Sept. 5. 800 w.

*1257. The New Berlin Waterworks (A popular description of a justly commended system of water supply). San Rec–Aug. 30. 900 w.

*1268. The London County Council and Water Supply (Editorial. A scheme to supply London with water from North Wales. System to compose reservoirs, 150 to 175 miles of covered aqueducts with a capacity of 200 million gallons per day, costing about 190 million dollars. Discourages the scheme on the ground of economy). Engng–Aug. 30. 4200 w.

Miscellany.

820. The Preservation of Natural Parks. Eng Rec–Aug. 17. 500 w.

821. The Transportation of Heavy Cables Through City Streets. Ill. E. P. Frederick (Interesting and complete description of methods and apparatus designed by the Broderick and Bascom Rope Company of St. Louis, Mo). Eng Rec–Aug. 17. 4800 w.

825. Philadelphia's Fire Houses. Ill. (Descriptive of what is claimed to be the most complete and probably the largest fire station in the world). Fire & Water–Aug. 17. 1500 w.

962. The City and the Engineer. A Paper by Robert E. McMath, reprinted from Trans. of Asso. of Civ. Eng. of Cornell Univ. (Municipal affairs and organization and the engineer's place and function therein). Eng. Rec–Aug. 24. Serial. 1st part. 3500 w.

*1094. Destruction of Town Refuse. Ill. (Description of plant). San Rec–Aug. 23. 1000 w.

RAILROADING

London to Aberdeen.

MR. CHARLES ROUS-MARTEN in *The Engineer* gives an interesting summary of "the decisive and final phase" (beginning Monday, August 19) of the recent great railway race noticed in this department for September. Some particulars of the distances traversed by the rival trains, and other details of the race, were presented in the review referred to. "The noteworthy point" in this final phase was that in the increase of speed, noted below, and the carrying out of "a timing which seemed phenomenal, and which not long ago would have seemed impracticable, if not impossible, the locomotive resources of the companies were never overstrained; indeed, were never taxed to their utmost. The actual arrival time at Aberdeen on Monday was 5.31, or 9 minutes early," the schedule time being 5.40 A. M. and the proposed time from London to the Aberdeen station being 9 hours and 40 minutes. "But, then, 20 minutes had been absolutely wasted in delays at Dalton, Edinburgh, and Dundee," due to various avoidable causes, and 2 minutes were otherwise lost by avoidable checks between stations; so that it appeared to be demonstrated that the run could be made in 9 hours and 8 minutes without quickening the actual speed. In fact, the time was reduced to 9 hours and 11 minutes on Tuesday. "But, just as the West Coast had beaten the East by 16 minutes on Monday, so it did on Tuesday, reaching Aberdeen ticket platform at 4.58, or 8 h. 58 min. from London. So arrangements were made for a fresh acceleration on the East Coast on Wednesday, which it was believed that the West Coast, with its extra 17 miles of distance and heavier grades, could not possibly equal.

"The quickening began from the outset. Potter's Bar Summit (12¾ miles) was passed in 15 minutes from the start, nearly 2 miles of the distance being on a rise of 1 in 105 and 1 in 110, and more than 8 at 1 in 200. Hatfield (17¾ miles) was passed in 19½ minutes, Hitchin (32) in 33, Huntingdon (58¾) in 55½, Peterborough (76¼ in 72. The 23¾ miles back to Stoke Summit were ascended, after the slack through Peterborough, in 24 minutes, and Grantham (105¼) was reached in 101 minutes, or in 29 minutes from Peterborough. Starting again from Grantham, Newark was passed in 14 minutes for the 14¾ miles, Retford (33¾) in 30½, Doncaster (50¾) in 46 minutes, Selby (69) in 62, and the arrival at York (82¾) was in 76 minutes. The engine from London to Grantham was No. 668, and that from Grantham to York No. 775,—both the same as on the Monday and Tuesday night, and both being of the older class of 8 ft. 1 in. singles. It will be observed the average speeds were 63.3 from London to Grantham, and 65.5 from Grantham to York, and that the entire run from King's Cross to York was made in 3 hours one minute, including stoppage, or in 2 hours 57 minutes actual running time. The North-Eastern now took its turn, and did its part admirably. A fine run of 79 minutes was made to Newcastle (80½ miles) by No. 1621, a new 7-ft. coupled bogie; but the ensuing rush to Edinburgh, 124½ miles, at the average rate of 66 miles an hour by No. 1620, was quite the sensation of the East Coast run. It delivered the train at Edinburgh at 2.19 a. m., or in 6 hours 19 minutes from London. This makes the 7 hours 26¾ minutes, which constituted the record in the race of 1888, look very small indeed. The North British Company now took on the train, and did some extremely fine work, when the difficulties of the road are taken into account. Dundee, 59¼ miles, was reached in 59 minutes, and Aberdeen ticket platform, 71¼ miles, in 76 minutes, the train arriving at the platform by 4.38, and entering Aberdeen Station at 4.40,—*i. e.*, in 8 hours 40 minutes from London."

In these runs, had the load been reduced to 50 or 60 tons "for racing purposes," a

very large saving of time would have been practicable. This was proved in the final rush of the entire racing period, when with a load "reduced to three bogie coaches, weighing about 68 tons in all, ... the Northwestern and Caledonian engines accomplished the fastest long-distance run in all railway annals, not merely beating the East Coast record by 8 minutes, but running 17 miles longer distance to do it; and it is noteworthy that for the whole of that extra 17 miles the West Coast gradients are from 1 in 88 to 1 in 75, and even 1 in 70,—the last being just out of Euston. This accentuates the wonderful character of the feat, which even the extreme lightness of the load does not deprive of its marvelous character."

Stimulated probably by this splendid record, and anxious to beat it, the New York Central and Hudson River Railroad Company, on the 10th September, ran the express train commonly known as "*The Flyer*" from New York to Buffalo at an average speed, exclusive of stops, of 64.34 miles an hour, thus beating very slightly the English record for actual running speed. The following is a record of the run:

New York	Distance.	Time.
Albany	143 miles	134 minutes.
Schenectady	17 miles	19m. 14s.
Utica	78 miles	71 minutes.
Syracuse	53 miles	49m. 30s.
Rochester	80 miles	73 minutes.
Buffalo	65½ miles	60m. 16s.

Total distance from New York..436½ miles.
Total time..... 407 minutes.
Average time, exclusive of stops, 64 1-3 miles.

The train was, however, very much heavier than the English train. The weight was 270 tons, and the train had accommodation for 218 passengers. Moreover, it is said to have run the entire trip against a strong head wind.

The Wear of Driving-Wheel Tires.

THE committee appointed by the Master Mechanics' Association to investigate the above subject have issued their report, an abstract of which is printed in *The Railway Review* (Aug. 17). The information was drawn from measurements of irregularities of wear of tires at the shops of three large western roads, covering periods of 5 and 22 years (in case of Union Pacific Railroad). "The report is divided into three parts, treating: *first*, the nature, location, and extent of the irregularities in the wear of driving-wheel tires, the methods employed in measuring and recording them; *second*, discussion of the forces causing the wear in tires of the eight-wheel and ten-wheel type of engines; *third*, deductions and conclusions." After going over the results in detail and illustrating them with diagrams, drawings, and tables, the article says that "there are two locations of maximum wear, one beginning at about 160 deg., reaching its maximum at about 220 or 230 deg., the other becoming pronounced at from 10 to 20 deg., and reaching a maximum at 50 deg. Both of these low points are connected from 220 to 50 deg. with the direction of rotation by a portion of the tire much more worn than that from 50 to 220 deg. To understand this, it must be seen that slight slipping through a small part of the revolution occurs usually on heavy pulls at slow speed, the beginning of the slip in this case occurring at the maximum of the coefficient of slip. At 20 miles per hour the coefficients are at a maximum at 40 to 130 deg. . . . . At 100 deg. the pressure on these wheels was almost at a minimum, and is much less than from 140 to 160 deg. The wear following 160 deg. is greater than that following 40 to 50 deg. for the same reason. The same conditions as to rail pressure occur for the left forward and back wheels 90 deg. back of those on the right side, and irregularities of the wear produced by the drivers slipping at considerable velocity should occur on the left wheels at points 90 deg. back of the corresponding points on the right wheels, or at 310 deg., and at 130 and 140 deg. . . . .

"There is no doubt locomotive tires wear without slipping, and there should be, and probably is, a portion of the irregular wear due to the pulverizing or crushing action being greater under heavy than under light loads. The experiment made by removing all the overbalance in the counterbalance of C. B. & N. Engine No. 150, when the irregularities of wear in the main wheel were almost exactly duplicated

in location, and to a remarkable degree in magnitude, together with similar experiments attended by the same general results, and the fact that switch-engine tires wear more evenly than even slow road engines, lead us to believe that their irregularities of wear are almost wholly caused by abrasion from slipping, and that the pulverizing of the steel from pressure alone is but of very minor importance. In conclusion, the committee was of the opinion that it is absolutely impossible to entirely avoid the irregular wear of locomotive tires in ordinary road service, and which is aggravated by sandy track, since these irregularities are due very largely to inequalities in the pressure of the driving wheels on the rail and the rotative force at different parts of each revolution, which are unavoidable in our present locomotive construction, and probably not entirely avoidable in any steam locomotive with reciprocating parts. They also believe that these irregularities of wear can be considerably reduced by the careful design and operation of our present type of engine, and would to this end recommend the observance of the following:

"(1.) Driving wheels should have ample weight for adhesion. (2.) Main rods should be as long as is consistent, in order to decrease the effect of angularity. (3.) The weight of the reciprocating parts, and consequently the overbalance in the driving wheels, should be as light as possible. (4.) As small a proportion of the reciprocating parts should be balanced as is consistent with smooth working machinery and good riding conditions. (5.) The driving boxes, shoes, and wedges should be well maintained and kept properly adjusted. (6.) Have a careful and competent engineer in charge who will avoid slipping the drivers."

The diagram illustrations used in the article to show relation of pressure on rail to revolution were made on an instrument devised by Mr. W. H. Lewis; it resembles somewhat the ordinary engine indicator.

Principles of Block Working.

OWING to recent discussions on the relative merits of American and English methods of block working, the attention of railroad men has been directed to the matter, with the hope that some way may be found to relieve the present practice of uncertainties arising principally from the personal equation of the operators. There is no system of checks by which all signals can be verified otherwise than by the operator himself. Mr. A. A. Anthony has taken up the discussion of this subject in *The Railroad Gazette* (Aug. 16). He classifies present practice as follows: "There are two simple methods of block working, each of which is in use, I believe. Under the one plan *C* (in a system of three block stations *A*, *B*, and *C*) notifies *B* of the passage of each train out of the block *BC*, and *B* admits each train on the condition that the last train has been reported clear by *C*; that is, the blocking is based on *clearances*. Under the other plan trains are not reported clear by *C*, but *B*, when a train is approaching, asks *C's* permission to admit the train to the block; if *C* is satisfied that the last train that entered the block has passed out, he gives permission or 'accepts' the train; *B* then gives a 'clear' signal. So we may say that the blocking is based on *acceptances*."

It will be at once seen that much depends upon the memory and vigilance of the operator. He may not only give a wrong signal under a mistaken impression, but may send signals to other than the proper stations, and even enter signals on his records in wrong columns. When running is very regular, he may accept trains from force of habit. Where the *clearance* and *acceptance* systems are used in conjunction, "a wrong 'clear' signal will not be given, unless errors on the part of both signalmen *coincide*." After taking up all possible cases likely to occur, the author arrives at these conclusions.

"(1.) It is essential that each train that passes out of a block should be reported by the signalman at the end of the block to the signalman at the beginning. (2.) The giving of a 'clear' signal, or its equivalent, for a train to enter a block, should depend upon the condition that the last train that entered has been reported 'out' in the regular course. (3.) The giving of

a 'clear' signal, or its equivalent, for a train to enter a block, should depend upon the permission of the signalman at the end of the block. (4.) A permission given for a train to enter a block remains in force until a train comes through that block. (5.) The giving of a permission for a train to enter a block should depend upon the condition that no previous permission is in force."

Electric and Steam Tugs-of-War.

As to the frequent reports of tugs-of-war between electric and steam locomotives, in which, by the way, the latter are invariably declared victors, the *Railroad Gazette* has something pertinent to say. After alluding to the reports in the daily papers, "which are supposed to know no better," and to some electrical journals "that ought to be more correctly informed," it puts the case in this way: "Broadly speaking, such tests are no possible criterion of the relative merits of the electric and steam locomotive. Provided each class of locomotive possesses sufficient power to slip its drivers, the heaviest machine will always win, regardless of the kind of power employed. The latest test of this character was made on the Nantasket Beach road. A heavy train was made up, to one end of which was attached a steam locomotive and to the other an electric motor, and it is stated that, when both were working to their full capacity, the electric machine pulled the steam engine and the train without trouble. All of which simply means that the electric locomotive, because of its heavier weight, possessed the greater tractive power. There are, of course, many other questions than mere pulling capacity, which must be considered in determining the relative merits of the steam and the electric locomotive, and neither should be declared the superior of the other because an engine weighing 60 tons, operated by one power, exerts a greater tractive force than the other machine, weighing 50 tons, driven by the other." This throws a deal of light upon a popular misconception of facts. There is no doubt whatever as to the powers of electric locomotives of the Baltimore and the Nantasket types,—to say nothing of what is coming,—but there is no sense in further disparaging that useful, well-tried animal, the iron horse.

Lack of Tramway Progress in England.

"WHY is it," the *Railway World* plaintively inquires, "that tramway progress is almost unknown in the British Isles, while elsewhere, even in other European communities, it is one of the most noticeable features of the past ten years?" Answering its own question, the *Railway World* justly remarks that it is certainly not because English engineers are wanting in skill or enterprise; the few opportunities granted to them at home have been successfully employed, and their achievements compare favorably with modern tramways elsewhere. It also calls attention to the various schemes of underground railroads in various stages of progress or completed in London, to attest that in one direction at least there is no lack of enterprise. "To find the real reason for our lack of progress we have to go to the legislative and official discouragements that hedge about the promotion of tramway projects. There is every reason to believe that the tramway industry would, if properly encouraged, prove as active in England as in America; but it must be able to employ the latest improvements in methods of traction, and to enjoy concessions as liberal as those granted to it elsewhere." There may also be something in the conservative habits of the British public, and the *Railway World* must have had this in mind when it adds that it is clearly the duty of tramway companies, and of all those interested in the promotion of tramway enterprise, to educate public opinion on the subject so that the restrictions which have so long retarded progress may be swept away. But how this is to be accomplished is not indicated.

Railroads Making More Money.

WITH the dread tales of ruin and national bankruptcy still in the air, we turn to the following from the *American Manufacturer*, given as an indication of coming prosperity in business: "A summing-up of

the railway earnings, as given by *Bradstreet's*, shows that the gross earnings of 145 railroad companies for the first 6 months of 1895 aggregate $349,099,773,—a gain of 3.6 per cent. over the corresponding period of 1894, which in turn showed a decrease from 1893 of 16.4 per cent. The net earnings of the same roads for this year aggregate $102,767,786,—a gain over last year of 8.1 per cent., and following a decrease in 1894 from 1893 of 18.8 per cent. An examination of the record 1 year ago shows that every group of American railroads showed decreases in gross receipts, varying from 10.4 per cent. in the case of the southern roads to as much as 21.5 per cent. for the southwestern roads. Decreases in net earnings were even more strongly marked, varying from a falling off of 7.4 per cent. in the case of the granger railroads to as much as 40.6 per cent. in the case of the southwesterns. This year the exact opposite may be said to be the case. It is true, there are some decreases in gross earnings this year from last,—notably in the case of the southern and granger railroads,—but there are also notably large increases in nearly all the other groups." The editor then continues: "That the enlarged business has been accompanied by careful management in the operating department is proven by the fact that, while gross earnings this year gained 3.6 per cent. over the first 6 months of 1894, the gain in net is relatively more than twice as much,—8.1 per cent."

Railroads are in such close sympathy with the industries and resources of our country that what affects one speedily affects the other. If railroads are making money, the shippers are making money, and, as the article rightly concludes, the outlook is for prosperity and an accumulation of wealth in the near future.

Needed Uniformity in Car Construction.

THE *Railway Master Mechanic* for June urges upon the attention of the Master Car Builders' Association the need of an agreement upon a system of "a reasonably correct distribution of the material and upon standard sizes for the principal timbers" in railway cars. It asserts the belief that "no more sensible work could be undertaken" by this association during the coming year.

The subject is treated as involving "problems of great importance to railroads and officials upon whom the responsibility directly falls. Aside from the framing of suitable rules of interchange, the one thing which would most facilitate interchange, and at the same time reduce the cost of freight-car construction, is the adoption of a standard freight car. This has been proposed a number of times, but we must admit that there appears to be very little disposition on the part of the various railroad companies or their master car builders to take this important step."

A table of the finished dimensions of the principal timbers in the freight cars of nine large railroads is presented. A study of this table discloses a considerable uniformity in some particulars, and a remarkable diversity in other respects. Length and width do not differ so much as expected. A conclusion reached from the drawings from which the table has been compiled is that "with one or two exceptions the amount of material used in the different cars does not vary greatly, and the different dimensions of parts arise more from a difference in the distribution of the material."

Present Practice in Railway Signaling.

AT the present time, when every accident draws a very serious amount of money out of our railways' already slim profits, it has become a matter of economy for them to adopt all known efficient safety appliances. In order to ascertain exactly what devices are actually in use, *The Railway Review* (Aug. 17) gives the results obtained by sending out questions to seventy-five principal railroads in English-speaking countries and colonies. These are very important, and show a remarkable uniformity in practise. However, "the great railway system of the United States, with 176,000 miles of road and 900,000 employees, and a passenger service unequalled in any other part of the world, cannot be placed in a leading position so far as its safety appliances are concerned. . . . The total

mileage of railways in Great Britain and Ireland is about 20,500; in India, about 18,000; and the Cape railways have a total mileage of 2635. In Australia there are about 12,000 miles, and in Canada about 14,000. In Great Britain and Ireland and the colonies the semaphore signal is universally employed as a main line signal, the disc signal being used only for sidings and shunting operations. In the United States thirty-four out of thirty-six companies were in favor of the semaphore, although the disc signal is used in connection with automatic systems, such as the Hall. In Great Britain, Ireland, and the colonies the 'danger' light for main line systems is universally red, and, as a rule, the 'all clear' light is green; a number of companies still use white as an 'all clear' signal, but it is likely that white will be wholly abandoned, and, when seen, will be treated as a danger signal. No caution signals are used there. The ground disc signal is more largely employed for sidings than any other form in Great Britain and its colonies, but some companies prefer dwarf semaphore signals. A few lines, such as the London and Northwestern Railway of England, use a purple light as a danger signal for sidings. In Great Britain and Ireland and the colonies distant signals are universally used. These are placed at distances varying from 300 to 1700 yds. from the home signal, but the general rule is to place the signal at about 800 yds. from the home signal on a rising gradient, and on a falling gradient from 1000 to 1200 yds. distant. Signals in England are, in a few cases, worked successfully by wire connections over distances of more than a mile, but as a rule it is not considered desirable to exceed 1200 yds.

"In England and Ireland and the colonies separate signal posts are provided for each signal arm in cases where one or more branches lead from the main line, these separate posts being in many cases carried by brackets, the more important signal being somewhat raised above the others for the sake of distinction. This practice applies to running tracks only, and, in the case of signals for subordinate tracks in the rear of the junction, it is the general practice to provide one signal post, and to place the several arms one above the other. It is the invariable practice of Great Britain that the top arm governs the left-hand line. The second arm governs the next in order, and so on. On all British railways it is the general rule to provide an independent distant signal for each home signal. As a rule, in Great Britain, the colonies, and the United States the only distinction that is made in the signal for a freight track running parallel to a main line is the provision of a ring on the arm, which is, as a rule, carried at a lower elevation; but no difference is made in the night signaling. Back lights are universally used to enable the operator to see whether the signal is lighted. In Great Britain it is the general practice to show a white back light in the 'danger' position of the arm, and in the 'clear' position the light is obscured . . . The tappet type of locking is the form most generally used . . . . Detector bars are used in Great Britain to some extent, to enable the operator to determine the presence of cars on lines which are out of his sight. In Great Britain derailing switches are commonly used on sidings; they are also used there on falling gradients."

After speaking of the application of power to signals, automatic torpedo apparatus, absolute block systems, the Sykes system, switch regulations, color-blindness tests, and devices not generally known, the article concludes thus: "In comparing the work accomplished in Great Britain to that of the colonies and the United States, it was found that in Great Britain little remains to be done further than perfecting details." This question was fully discussed before the fifth section of the International Railway Congress by Mr. A. M. Thompson Mr. H. Raynor Wilson adding some notes on recent improvements.

The Condition of American Railways.

THE *Railway Review* (Aug. 31) publishes some advance statistics from *Poor's Manual for 1895*, which are interesting by reason of the accurate figures on the condition of an industry upon whose development the growth of many other industries

depends. The effect of depressed trade has been keenly felt and immediately evidenced by the transportation lines. The table below gives a general summary of the results of the operations during the past two years.

	1894.	1893.	Rate of Increase or Decrease.
Miles R.R. Operated	175,444.11	173,370.07	1.19
Tons Freight Moved	675,129,747	757,464,480	10.85
Freight Mileage	82,289,400,498	90,552,087,290	9.12
Passengers Carried	583,248,007	628,965,973	7.25
Passenger Mileage	13,600,531,635	15,146,711,952	10.20
	$	$	
Earnings fr. Freight	700,477,409	808,494,668	13.36
Earnings fr. Pass'gr	276,031,571	311,978,342	11 52
Miscel. Earnings	91,134,533	88,168,488	3.36
Earnings, "L" R'ds.	12,661,502	13,976,792	9.41
Total Gr. Earn's	1,080,305,015	1,222,618,290	11.64
Net Earnings	322,539,276	364,591,109	11.53
Earn. per T. per M.	0.851 cent.	0.893 cent.	4.70

"The following statement shows that, notwithstanding the steady increase in the average capitalization (share capital and bonded indebtedness combined) per mile of railroad, the average of such capitalization on the basis of total track mileage is being rapidly lowered, the decrease in this respect in the past 20 years having been about 5 per cent. as against an increase on basis of road mileage of nearly 2 per cent."

Years.	Railroad. Total RR.	Railroad. Total Track.	Total Stock and Bonds.	Stock & Bonds per Mile of— Railroad.	Stock & Bonds per Mile of— Tr'ck
	Miles.	*Miles*	$	$	$
1875	74,096	91,611	4,400,869,412	59,394	48,038
1885	127,729	160,597	7,583,424,898	59,371	47,220
1890	163,420	208,303	9,746,141,603	59,639	46,788
1894	178,119	232,919	10,741,363,319	60,315	45,686

Figures for the financial years quoted are for fiscal years ending at various dates. However for the purposes of comparison with other years the figures are sufficiently close.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Technical Journals—See Introductory.

*694. Mountain Railroads in Mining Regions. Ill. James R. Maxwell (Problems in difficult engineering). Eng Mag-Oct. 3500 w.

*712. The Railway Race to the North (Editorial. East and west coast routes; London to Aberdeen; great acceleration in speed). Engng, Lond-Aug. 2. 3500 w.

*724. Signals at Liverpool Street Terminus. Ill. (Arrangement of switches and locks). Eng, Lond-Aug. 2. 1200 w.

*735. Chicago's New Overhead Electric Railway. Ill. (Termini; routes; structure; stations; electrical equipment; rolling stock). Ry Wld-Aug. 3000 w.

*736. McConnell Locomotives. Ill. Clement E. Stretton (A study of English locomotives, 1845-60). Ry Wld-Aug. 2000 w.

752. Automatic Couplers and Air-Brakes (Review of statistics; criticism of new law). R. R. Car Jour-Aug. 800 w.

753. Postal Car, Baltimore and Ohio R. R. Ill. (Working drawings and details). R R Car Jour-Aug. 1500 w.

754. Handholds and Height of Drawbars (Extension of time in which to comply with the law). R R Car Jour-Aug. 1500 w.

755. Painting Freight Cars (Durability). R R Car Jour-Aug. 600 w.

756. A Pressed Steel Diamond Truck Frame. Ill. (Description of a design by Charles T. Schoen). R R Car. Jour-Aug. 1000 w.

762. The Employment of Two or Several Motors on Cars or Locomotives with Respect to Skidding. Paul Hoho (Examination from the point of view of the slipping or skidding of the wheels. Conclusions unfavorable to this disposition). Elec Ry Gaz-Aug. 10. Serial. 1st part. 1300 w.

764. Duties and Responsibilities of Station Agents (Manual issued by E. O. Hopkins of the Louisville, Evansville & St. Louis Railroad to the agents of that company for their information and guidance). Ry Rev-Aug. 10. 3400 w.

782. The Braking of Trolley Cars (Editorial reply to criticism in American Machinist). Elec-Aug. 14. 1400 w.

806. Train Policing. C. A. Wilson (Abstract of paper read at meeting of Central Asso. of RR. officers). R R Gaz-Aug 16. 1800 w.

807. Railroad Track Melted by a Stray Electric Current. Ill. (North Attleboro, Mass.) R R Gaz-Aug. 16. 500 w.

808. Principles of Block Working. C. C. Anthony. R R Gaz-Aug. 16. 2000 w.

*811. The Hall Normal Danger Signal System (Credit is given to the United States for being much in advance of England in automatic signalling. The Hall system in use on 25 American roads is there described and illustrated as an example of the progress made in this kind of signalling). Engng-Aug. 9. 4500 w.

850. Motor Cars for Chicago's North Side

We supply copies of these articles. See Introductory.

Loop Lines. Ill. (Description, with reasons for introducing). W Elec–Aug. 17. 800 w.

*856. The Railway Race to Aberdeen. Charles Rous-Martin (Race between the east and west coast routes. The achievements constitute an epic in railway history). Eng, Lond–Aug. 9. 3400 w.

*860. Concentrated Loads (Editorial Comments on methods used in calculating). Eng, Lond–Aug. 9. 1900 w.

*862. Railway Problems in Victoria. View of an ex-Minister. Trans–Aug. 9. 3500 w.

883. The Present Situation in Railway Signaling (Notes compiled from answers to questions sent out by the International Railway Congress). Ry Rev–Aug. 17. 2200 w.

884. Telegraph Department of the Michigan Central Railroad. E. E. Torrey (System different from that used on most roads—The single order system). Ry Rev–Aug. 17. 1200 w.

885. The Wear of Driving Wheel Tires. Ill. (Summary of report presented at the Alexandria Bay Convention of the Master Mechanics Association). Ry Rev–Aug. 17. 2800 w.

887. The Commercial and Railroad Side of Car Service. A. L. Gardner (Read at the meeting of the National Asso. of Car Service Managers). Ry Rev–Aug. 17. 2000 w.

891. Hints on the Maintenance of Electric Railway Cars. Tito Toscani. Elec Rev–Aug. 21. 500 w.

*894. Tracks Are Private Property (Judge Tuley holds that Chicago City Railway has an easement in the street by virtue of its ordinance and contract with the city, and that its rights cannot be taken in whole or in part without compensation). St Ry Rev–Aug. 6500 w.

*927. Light Railways for the Transport of Sugar-Cane in Australasia. Charles Edward Forster (Earthworks and gradients; bridges and culverts; permanent way; rolling-stock). Ind & Ir–Aug. 16. 1100 w.

944. Freight Trains by Water (An enterprise proposing to carry freight cars on barges from Peshtigo, Wis., to Chicago). Ry Age–Aug. 23 600 w.

945. A Proposed Railway Equipment Car Pool. J R. Cavanagh, with editorial (A design to save the 25 to 40 per cent. excess of freight cars now required). Ry Age–Aug. 23. 1400 w.

946. Railway Relief Organizations in the United States. W. B. Outten (Discussion of the situation). Ry Age–Aug. 23. Serial. 1st part. 2200 w.

947. Locomotive with One Pair of Drivers. Ill. (Description and dimensions of details). Ry Age–Aug. 23. 200 w.

948. The International Railway Congress (Discussion Mr. Aspinall's paper on Express Locomotives, bringing out some local and special needs in compound and high-pressure locomotives). Ry Age–Aug. 23. 1700 w.

949. The Chicago Interchange Agreemeut (Details with names of railroads adopting it). Ry Age–Aug. 23. 1400 w.

956. Railroads Making More Money (Editorial. Statistics showing gain in earnings over 1894). Am Mfr & Ir Wld–Aug. 23. 500 w.

*978. Fireless Locomotives (The engine is charged with steam from the generators situated at appropriate stations. Description and dimensions). Prac Eng–Aug. 16. 1000 w.

*979. Heating Railway Trains by Steam and Compressed Air Combined (The system used on the Eastern Railway of France; has the advantage of keeping the pipes clear of water without wasting steam at rear car). Prac Eng–Aug. 16. 1500 w.

981. Repairs and Renewals of Railway Rolling Stock. Alfred John Hill (Results of experiments; analyses of materials and effect of wear). Ry Rev–Aug. 24. 2500 w.

982. The New Eight-Wheel Passenger Locomotive on the C. C. C. & St. L. Ry. Ill. (Complete description, drawings and specifications). Ry Rev–Aug. 24. 2500 w.

*999. The Railway Race for the North (Comments on the race between the east and west coast routes in England). Trans–Aug. 16. 2700 w.

*1000. Forty Years of Railway Progress (Tabulated statement showing capital cost, etc., of the railways in Great Britain). Trans–Aug. 16. 900 w.

1001. Nassau Electric Railway of Brooklyn, N. Y. Ill. (Descriptive. Electrically-welded rail joints. Editorial comments). Elec Ry Gaz–Aug. 24. 1400 w.

1035. Single-Driver Express Locomotive; Philadelphia and Reading R. R. Ill. (Description with specification). Eng News–Aug. 29. 1350 w.

*1045. Right and Wrong Way to Start a Car (Illustrated by diagram). St Ry Rev–Aug. 15. 400 w.

1047. The New York Central and Hudson River Railroad—Standard Types of Permanent Way. Ill. (Sections of rails with fastenings and specifications). Sci Am Sup–Aug. 31. 200 w.

1050. Tests of Locomotives in Fast Passenger Service. Ill. (Tests of two locomotives determining relative efficiency with specifications and cards). R R Gaz–Aug. 30. 900 w.

1051. A Combination of Grafton's Signal Blades and Carter's Signal Lights (Suggestion of improvements and description of practice). R R Gaz–Aug. 30. 1800 w.

1052. The New Interchange Association (Revised agreement adopted July 30). R R Gaz–Aug. 30. 1200 w.

*1078. The Great Railway Race. Charles Rous-Marten (Comparison of time made by railroads on east and west coast of England, between London and Aberdeen). Eng, Lond–Aug. 23. 2500 w.

†1086. The Detroit Citizens' Street Railway Company. Ill. (Complete description of plant and organization). St Ry Jour–Sept. 2800 w.

†1088. The Effect of Service on Street Car Bodies. Ill. (Construction of floors and platforms). St Ry Jour–Sept. Serial. 1st paper. 2500 w.

We supply copies of these articles. See introductory.

†1089. Street Railway Rolling Stock. W. E. Partridge (General design and construction of passenger cars). St Ry Jour–Sept. 2200 w.

1107. Grabirons and Handholds. Ill. (Report of the Committee of the Master Car Builders' Asso). Ry Age–Aug. 30. 600 w.

1108. Tubular Steel Underframe for Cars (Brief description with drawings of plan and elevation). Ry Age–Aug. 30. 180 w.

*1110. The Railways of India (Earnings, traffic and general financial condition). Ry Times–Aug. 24. 2000 w.

*1111. The Railways of Ceylon (Itemized comparison of earnings in 1893 and 94). Ry Times–Aug. 24. 400 w.

*1112. 70000 Pounds Capacity Coal Car, Pennsylvania Railroad. Ill. (Description and dimensions). Nat Car & Loc Build–Sept. 900 w.

*1113. Single-Driver Locomotive, Philadelphia & Reading R. R. Ill. (Description with specifications of a compound type of locomotive). Nat Car & Loc Build–Sept. 400 w.

1136. The Victoria Nyanza Railway (Proposed route from Mombasa to Victoria Nyanza). Trans–Aug. 23. 1700 w.

*1144. Dead Weight (The designing of R R rolling stock with reference to weight and strength of bridges)). Am Eng & R R Jour–Sept. 2500 w.

*1146. Standard Cars on the Southern Pacific Railroad (Circular of the Southern Pacific Railroad Co. giving instructions for the careful determination of the merits of 1,300 freight cars built to a common standard and in use on that road). Am Eng & R R Jour–Sept. 900 w.

*1149. New Compound Locomotives for the St. Gothard Railroad. Edward Sauvage (Specification, description and drawings in section and elevation of a three and four cylinder locomotive). Am Eng & R R Jour–Sept. 2200 w.

*1150. Railway Rolling Stock. Alfred John Hill (Wear and durability of railway rolling-stock in England). Am Eng & R R Jour–Sept. 1000 w.

*1159. Norfolk and Western System of Maintaining Standards. A. S. (An attempt at uniform practice in the repair shops and a tendency to make parts interchangeable). Loc Engng–Sept. 800 w.

*1160. Blind Tires on Locomotive Drivers. D. Brown (Reasons why they are unnecessary). Loc Engng–Sept. 200 w.

*1166. Railway Enterprise in Egypt. (Report of Frederic C. Penfield, agent and consul general for the U. S. at Cairo, April 6, 1895). Bd of Tr Jour–Aug. 600 w.

*1188. The Uganda Railway (Discussion before the House of Commons by the great African explorer, H. M. Stanley). Ir & St Tr Jour–Aug. 24. 1000 w.

1194. A Proposed System of Rapid Transit for New York City (System devised by A. H. Thorp, proposing six lines of tracks around the entire city, along the water-fronts, and a central longitudinal line of four tracks). Am Arch–Aug. 31. 1500 w.

1205. The Northwestern Elevated R. R., Chicago, Ill. Ill. (A complete, concise description, with map of route and inset plate of construction details). Eng News–Sept. 5. 3000 w.

†1218. Terminal Freight Yards. W. A. Garrett (Paper read at meeting of St. Louis Supt.'s Asso). Ind & East Eng–Aug. 3. 1800 w.

†1219. Rolling Stock for Pioneer Railways. Ill. (Description of cheap and narrow gauge rolling stock used in India and S. Africa). Ind & East Eng–Aug. 3. 1300 w.

*1236. The End of the Railway Race. Charles Rous-Martin (The great railway race from London to Aberdeen). Eng, Lond–Aug. 10. 2400 w.

1241. Conclusiveness of Decisions of Engineers (Case of Mundy v. L. & N. Ry. Co. The contractor disputed excavation measurements, though the contract declared the engineer's estimate to be conclusive. The U. S. Circuit Court decides that the engineer was not an arbitrator but a member of one party). Ry Mas Mech–Sept. 700 w.

1243. Handling Scrap at the Pan Handle Shops in Indianapolis (A very efficient system as practised at the Pennsylvania shops, composed of labeled bins on platforms by the "in" and "out" tracks. The cutting up is done by a compressed air shears. Illustrated in detail). Ry Mas Mech–Sept. 600 w.

1244. The most Powerful Eight Wheeled Passenger Engine in the World. Ill. (It is built for the C. C. C. & St. L. Ry. Weighs alone 126,000 lbs., two single cylinders 20x24 in. working under 200 lbs. steam pressure. An average trip is also given). Ry Mas Mech–Sept. 2000 w.

1245. Performance of the New Passenger Engines on the Pennsylvania Railroad. Ill. (An engine approaching the mile a minute speed, and doing excellent service; it is of the 1895 design, with 18½ x 26 in. cylinders, 80 in. drivers, carrying 180 lb. pressure). Ry Mas Mech–Sept. 600 w.

1246. Equipment of a Wrecking Train. W. S. Scott (The train is composed of one derrick car, crane style; two cabin cars and flat cars, one loaded with trucks. A description of organization, tools employed and full equipment, with method of working and report). R R Gaz–Sept. 6. 800 w.

1247. The Northern Pacific and the Great Northern (A discussion *pro* and *con* of the proposed alliance of these two great roads. An editorial opinion without conclusion). R R Gaz–Sept. 6. 2000 w.

1277. Car Lubrication Extraordinary. "A Reader" with Editorial (A run of seven months without lubrication of a car on the Norfolk and Western R R). R R Car Jour–Sept. 900 w.

1295. Yard Work as Applied to Extra Switching, Including Cars for Destinations. J. Turner (Waste of time; and ways in which time may be saved in switching; advocating more systematic working). Ry Rev–Sept. 7. 2400 w.

We supply copies of these articles. See introductory.

SCIENTIFIC MISCELLANY

Fixation of Atmospheric Nitrogen.

ONE of the oldest problems in industrial chemistry is the discovery of a practical commercial method of obtaining and holding in chemical combination nitrogen obtained from the atmosphere. Dr. Francis Wyatt, in *The Engineering and Mining Journal* (August 10), states that the solution of this problem, which has been sought for 50 years, is of "immense importance to mankind." "Theoretically, and in the laboratory, the problem has long been solved. If it has not been solved hitherto industrially, and on a large scale, it is not only because of mechanical difficulties, but because experimenters have not properly understood the negative and unstable properties of nitrogen itself. The progress of science has facilitated the combination of carbon, hydrogen, and oxygen, independently of nature, and has taught us to build up from them, synthetically, many organic compounds identical with natural bodies. . . . In the case of free nitrogen the combination with either or all of these elements is less easy, because we encounter in it a greater natural lack of affinity, and general inertness under all ordinary conditions of temperature and pressure. In order to surmount the difficulties, we must fulfil certain necessary thermal, chemical, and mechanical conditions. When these have been definitely established and complied with, we may expect that the most marvelous developments will immediately follow, because nitrogen is at once the most costly and the most essential component of all organized life.

"All organic bodies can be made to part with their nitrogen in the form of ammonia. Why cannot we, therefore, with cheap and plentiful ammonia as the starting point, build up artificially and rapidly many substances of incalculable value, which are in constant demand for the purposes of industry, and for the supply of which we are now entirely dependent on the diminishing reserves of nature and its slow processes of renewal? The question is not a hasty one, nor is there anything impossible or improbable in the hypothesis."

The numerous compounds now produced by laboratory methods into which nitrogen enters, though of great importance and value, are insignificant when we consider "two other important fields which would be benefited beyond the bounds of calculation by the cheap production of cyanids and ammonia from atmospheric nitrogen. The first and most interesting to mining engineers and metallurgists is in the treatment, by the cyanid process, of those lean ores containing gold and silver, which at the present time abound, and which yet have no commercial value. The second and most interesting to agriculturists is in the restoration to the soil, at a comparatively nominal cost, of the nitrogenous element of fertilization which is yearly removed by the crops, and the actual loss of which has been estimated by Professor Alvord at $720,000,000 for this country alone. There is, then, a boundless demand for nitrogen which can never be satisfied from any source now known to us. It is true that there is an abundance of nitrates in Chile and Peru, but they are far too costly for general use; and, as to ammonia, it is naturally too expensive, the whole of our present supply being derived from a small percentage of the total nitrogen contained in coals either in the manufacture of coal gas, or from the gases of the coke oven and the blast furnace. As to cyanids, we derive our supply from yellow prussiate of potash, and this is still made almost exclusively in the old-fashioned way by the fusion of such valuable organic matter as dessicated blood or horn with carbonate of potash and iron filings. In the face of these facts, and in view of the fascinating nature of the subject, I might well be excused for entering into minute

details concerning the fixation of atmospheric nitrogen, but the chemical literature of the past few years is so pregnant with records of experiments and failures that I shall content myself with a very brief retrospective glance."

The article then rapidly passes over the course of experiments directed to the fixation of nitrogen, ranging from those of Bunsen and Playfair in 1845, to 1893, when Fogarty perceived the reason of former failures and struck out a new path. Dr. Wyatt says the processes all failed "because they made no allowance for the most essential condition attendant upon the combination of carbon with nitrogen,"—to wit, "that one of the elements should be nascent, and endowed with the chemical energy pertaining to the nascent state." Fogarty's process is thought to be full of promise. "The latter now uses no fixed carbon for any other purpose than the manufacture of a highly superheated producer gas consisting chiefly of oxids of carbon, free hydrogen, and nitrogen." He passes this gas into and through a suitable retort, and simultaneously drives in with it in the same direction a measured volume of hydrocarbon vapor derived from burning fuel oil. The mixed gases come in contact with a measured quantity of incandescent and finely-comminuted lime, which showers down from the top of the retort. His gas at this stage contains no free oxygen or carbonic acid, and the hydrocarbons are, therefore, ultimately decomposed into acetylene, free carbon, and hydrogen, all of which may combine with nitrogen and the lime to produce calcium cyanid and subsequently ammonia and fuel gas."

Passing Dr. Wyatt's explanation of the reactions which take place in the Fogarty furnace, as too technical for other than chemical readers, we will close this review with the following statement, which, coming from such an authoritative source, has almost the force of a prediction.

"The question being satisfactorily disposed of in this manner, I believe that the thermal and chemical conditions required by the new Fogarty process are well established. The remaining condition involves the construction and arrangement of certain mechanical details connected with the new furnace which is now about to be erected, and of these I do not feel competent to speak with authority. If the difficulties in this direction are successfully overcome, as it is claimed they easily can be, the production of cheap cyanids and ammonia from the fixation of atmospheric nitrogen will at once be placed upon an industrial and commercial basis, and chemistry will bind and place at our feet the hitherto least tractable of nature's elements."

Electrical Measurement of Starlight.

A NEW method of measuring the light of the stars, very much more rapid than the previously-existing method,—action on a photographic plate,—is described in *Nature*. The principle of the new method is the difference of potential produced by lights of different intensities in a photo-electric cell. "Such a cell is constructed with selenium, aluminum, and liquid œanthol. If we take a strip of clean aluminum, —say ½ in. long, $\frac{1}{16}$ in. wide, and thick enough to be fairly stiff,—lay it on an iron plate which is heated by a Bunsen flame, and place on the end of the strip a very small particle of selenium, this selenium will melt and form a small black globule of liquid. Let the flame be now withdrawn, and the globule of melted selenium spread over the end of the aluminum strip by means of a hot glass rod, so that it forms a thin uniform layer of area $\frac{1}{10}$ in. square on the end of the strip, and let this dark layer cool to about 217° C., or a few degrees below its melting point. Now apply heat again to the upper surface of the iron plate until the aluminum strip becomes nearly hot enough to remelt the layer of selenium. In this process the color of the layer will gradually change from black to a greyish brown. When it is just on the point of melting, withdraw the heat and blow over its surface; this will instantly check the tendency to melt, and will leave the surface of the selenium in the state in which it is most sensitive to light. If this strip (or rather its selenium-covered end) is immersed in a glass

tube containing acetone or œnanthol, and connected with one pole of a quadrant electrometer, whose other pole is connected with a platinum wire sealed into the glass tube, we have a photo-electric cell, in which the action of light falling on the selenium layer results in giving the selenium a positive electric charge and the liquid a negative one, the former charge being conveyed to one pole of the electrometer by the aluminum plate, and the latter to the other pole by the platinum wire sealed into the cell.

"Roughly speaking, the difference of potential produced in such a cell as this by ordinary diffused daylight is something between one-third and one-half of a volt."

About the first of the year 1894 Mr. Geo. S. Minchin, the author of the article reviewed, made an important improvement in the photo-electric cell. This improved cell remains constant about 3 weeks, whereas the earlier cells began to deteriorate in about 6 hours. The conversion of light into electromotive force, as exemplified by this cell, is exceedingly interesting.

"In the figure *C C* is a cork in which the glass tube, *B*, containing the aluminum wire at the end *A*, and the attached platinum wire, fits, this cork fitting tightly into the side of the glass cell which contains the liquid. The tube, *B*, passes close up to a quartz window, *Q Q*, cemented to the cell opposite the cork, *C C*. The light of the star is received on the window, *Q Q*, and is made to fall on the selenium layer at the end, *A*, of the tube, *B*. A platinum wire, *P*, is sealed into the bottom of the glass cell, and conveys the charge taken by the liquid to one pole of the electrometer, while the platinum wire, *P*, conveys the charge taken by the selenium to the other pole of the electrometer; *S* is a ground stopper at the top of the cell, where the liquid is poured in.

"This cell is fitted into a holder which can be fixed to a telescope in place of the eye-piece; and this cell-holder allows of the adjustments which are necessary to bring the point, *A*, to the position of the image of a star."

With this instrument Mr. Minchin, assisted by Professor Fitzgerald and Mr. Wilson, measured the electric-motive force of "Jupiter, Saturn, Vega, Arcturus, Regulus, Procyon, and some other stars last April, in Mr. Wilson's observatory at Daramona, Westmeath. The telescope used was Mr. Wilson's 2-ft. reflector." The

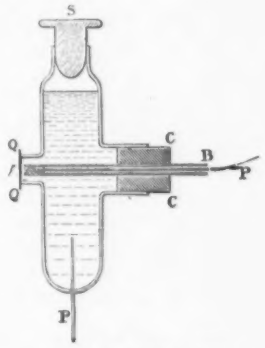


PHOTO-ELECTRIC CELL.

extreme sensitiveness of the cell to light, Mr. Minchin says, is such that an ordinary paraffine candle held at a distance of 9 ft. from the window, *Q Q*, produces an electromotive force of about 0.03. The light of Vega concentrated in the 2-ft. telescope produces a little more deflection in the electrometer than the candle does. The electromotive force of Arcturus was 82 per cent. of that produced by the candle; that of Saturn 56 per cent. A comparison of the results obtained by this method and those of the photometric method is made, in the course of which it is shown that agreement between these results is not to be expected when two stars of different colors are compared.

The Maxim Flying Machine.

THE status of this celebrated undertaktaking in July of the present year is described by A. G. Greenhill in *Nature* (Aug. 1). On July 5 a large party of scientific men visited Baldwin's Park, Bexley, England, by invitation of Mr. Maxim, and were treated to an exhibition of the machine and tests of its lifting and sustaining capacity. "The invitations were carefully distributed among those who were competent to judge of the magnitude of the task

to be attempted, and who were prepared to examine closely the ingenious mechanical details by which it was clearly demonstrated that the machine had ample power to lift itself off the ground, carrying with it a supply of fuel and water and a crew for the navigation.

"The Bexley machine is purposely designed of extreme size with the intention of thoroughly testing and elaborating the details of mechanism, and of measuring the lifting power within immediate reach of a workshop and skilled mechanics, more than of actually taking to the air; this will probably be first attempted with a much smaller machine, capable of lifting one man, of jockey-like proportion and mounted on a boat on a lake, so that short flights, like those of a flying-fish, can be attempted for initial practice.

"The lifting force of the machine is measured automatically as it runs along a railway track about ⅛ mile in length, and the machine is prevented from taking to flight by wheels running underneath outer wooden rails. Much yet remains to be done in the way of practice in vertical steering before taking leave of the earth, the chief difficulties of the aviator beginning when he wishes to descend and alight on the ground again."

"The machine, complete, with water, naphtha fuel, and crew of three men on board, weighs 8000 lbs." With a pressure of 275 lbs. of steam per square inch, the engines develop 360 h. p. The thrust of the screws is 2000 lbs., and the lifting effect of the aeroplanes and wings (4000 sq. ft. area) is 10,000 lbs. A thrust of 2000 pounds at 45 miles an hour gives 240-thrust horse-power; or, with a speed of advance of the screw of 60 miles an hour, 320 indicated horse-power.

"The total projected disc area of the screws is 500 sq. ft., each screw being nearly 18 ft. in diameter, with a pitch of 16 ft., thus requiring three hundred and thirty revolutions a minute to give a speed of advance of 60 miles an hour.

"Mr. Maxim calculates that, after making all allowances, he can at present lift 28 lbs. per horse-power; but that, with improvements, he hopes to raise this figure to 50 or 60 lbs., and then a machine could take a flight of 500 or 600 miles.

"When the machine is perfected, Mr. Maxim claims that the railway may be dispensed with, and that a short run over a moderately level field will enable it to attain the velocity necessary to rise. As far as landing is concerned, he says that the aerial navigator will touch the ground while moving forward, and the machine will be brought to rest by sliding on the ground for a short distance. In this manner very little shock should result, whereas, if the machine is stopped in the air and allowed to fall directly to the earth without advancing, the shock, though not strong enough to be dangerous (?) to life or limb, might be sufficient to disarrange or injure the machinery."

Of course this implies a tract of land of sufficient size, and having surface of a proper character, to permit a safe landing. If the machine be employed for regular traffic, as river steamboats are, such landings could be provided. But it has generally been supposed that Mr. Maxim's aim was to produce a machine applicable to military service, and landings of the kind considered are not portable. From a military point of view the lives of the crew might not be important, after enough skilled navigators of flying machines have been trained to the art; but the crippling of the machine might be attended with serious derangement of plans, and other bad consequences, not to mention the item of cost, which would not be trifling. The problem of artificial flight cannot be considered as fully solved till machines are constructed that can come down easily and safely upon any handy bit of level ground, as pigeons alight upon wheat fields.

"The aeroplanes and wings are mounted on a slope of about 1 in 8. These surfaces are formed of canvas, stretched on a skeleton frame-work of hollow steel rods for the struts, and thin steel for the ties; the large central æroplane is composed of two parallel canvas surfaces, with a space between, and in this way the shape is preserved better; and the general set of the wings, smooth, like cardboard should ex-

cite the envy and stimulate the imitation of our sailmakers for yacht racing. The front and rear wings are pivoted about a horizontal axis, so as to act as rudders in a vertical plane."

The machine is started from a position in which it has been retained by being tied to an indicator post; "the propellers are then set in motion, and soon drive gales of wind in their wake. When the pull of the rope has reached a definite amount,—say 2000 lbs.,—a hook is released, and the machine starts on its journey along the track. Dynamometers register simultaneously the thrust of propellers, so that much interesting information concerning the dynamics of propulsion can be obtained here, especially if Mr. Maxim will stretch a wire carrying ribbons across the axes of the propellers, in front and in rear, to measure the direction of the air currents. The speed Mr. Maxim deals with is about double the speed of the torpedo boat in water; but the effect of 'cavitation' in water, which is beginning to trouble the naval architects, is one which will not concern the propeller working in air. Now that the main mechanical difficulties of construction have been overcome, a longer track is required for the purpose of practice in vertical steering while the machine is off the ground but bearing upwards against the outer rails. It is unfortunate that difficulties should have been thrown in the way of making an extension of the present track beyond the domain of Baldwin's Park; so another practice ground, perhaps a sheet of water, must be found, not too far from headquarters or from skilled assistance."

Contamination of Ice.

IT used to be thought that ice purified itself in freezing. When impure water freezes very slowly, and remains, while freezing, in a large mass, perfectly still, some parts of the ice will be found to have nearly or quite freed themselves from mechanically-suspended impurities and even of dissolved matters; but this action is rarely uniform throughout the mass, and it is still more rare that the perfect quiescence, essential to such a result, is met with in natural bodies of water relied upon as a source of ice supply.

The Engineering Record (Aug. 10) editorially declares that the notion that ice is generally pure must be abandoned, and adds that "engineers have long called attention to the dangers to public health which are invariably created when ice is taken from bodies of water carrying dangerous pollution." This would seem to imply that the knowledge of the fact stated has been diffused for a greater period than is really the case. We do not remember anything of an authoritative character on this subject printed earlier than 1880, about which time comparisons between the purity of machine-made ice and natural ice were made, and the subject of impurities in natural ice began to attract serious attention.

The Engineering Record is, however, probably right in the supposition that a recent Chicago ordinance is the first prominent example of municipal legislation limiting the amount of impurity in ice offered for sale to citizens. We can recall no other instance; but the example is a good one, and will doubtless be followed in other cities.

"In April last there was passed by the council of the city of Chicago, and approved by the mayor, an ordinance setting forth certain provisions in regard to the pollution of ice supplied by the local ice companies of that city, among which are found the limitations of 0.009 part per 100,000 for free ammonia and 0.09 part per 1000 for albuminoid ammonia, together with one or two others of a similar character, and one requiring that no ice shall be 'cut or taken from any river within 3 miles of any town or city of over twenty thousand inhabitants, or cut or taken from any lake, pond, hole, or excavation' which has been subject to contaminations described in the act.

"Probably no sanitary authority will criticise the preceding limits as being too severe or unnecessarily low for the safety of the public health. It is well known, of course, that the degree of danger arising from the pollution of either water or ice is to some extent inferential when it is

based solely on chemical analysis; but the latter is essential, and it is difficult to see how higher limits could properly be permitted in a municipal ordinance. The same act also contains a provision forbidding the selling or keeping for sale of any ice containing pathogenic bacteria. The ice companies object, perhaps not unnaturally, to a rigorous enforcement of such an ordinance, and the matter has attracted considerable attention in the city of Chicago from many parties interested on both sides of the question. A large amount of ice is taken from waters within the limits of the city, and a number of chemical analyses which have been made of such ice appear to indicate an excessive pollution, although it is still an unsettled matter just what portion of the ice offered in Chicago is sufficiently free from contamination to raise its character above question."

The ice supply for New York city is largely derived from the Hudson river, and much of it is harvested at short distances below towns situated upon the banks of the river. Usually the ice is formed rapidly during periods of severe cold, and therefore is made under conditions favorable to retention of impurities. Many of the impurities in ice are chemically produced and held in solution; but bodies of filth are often suspended in the ice, and some of them are disgusting to contemplate in an article of common dietetic use. The germs of bacteria are, however, the most dangerous when they are present in ice.

The concluding remark in this editorial is worth heeding. "It is to very little purpose to secure a pure and uncontaminated public water supply while its users melt ice in it containing bacteria characteristic of many acute diseases, as well as other forms of pollution which induce physical conditions inviting attacks of disease. The special line of contamination is a source of no little danger to the public health, and it will eventually be found that the origins of all our ice supplies will have to be guarded from pollutions of any kind with precisely the same kind of care which is exercised in regard to sources of potable water, or else dependence will have to be placed upon the artificial production of ice from distilled water. Either method is feasible, as experience has already shown, and it will be impossible to reach a reasonable sanitary condition in respect to ice consumption until healthful ice is supplied to the public by one or the other of them."

Frauds in Textile Goods.

A WRITER who signs himself "Randolph" in *Boston Journal of Commerce* makes an exposure of several fraudulent practices, of which purchasers of textile goods ought to be made aware. He asserts that "at the present time there is scarcely any class of industrial production" in which these practices do not prevail. "The finisher of cotton and wool goods has come to feel the effects of these practices, and it results that he often is called upon to be an accomplice in them."

"Randolph," who may have special reasons for adopting a *nom de plume*, evidently speaks from the book; but he deals particularly with only that class of adulteration by which the specific weights of textiles are fraudulently increased. By some of these methods the weights of fabrics may be increased from 3 to 4 ounces per yard, and these practices have become so systematic that a market has been found for special machines used in "weighting" cloths. Woollens, cottons, and silks are "weighted."

"Two substances may be mentioned as being used for this purpose; one is silicate of soda, and another is a mixture of barium chlorid and Glauber's salt. In the latter case the two substances are dissolved in water separately, then mixed together, and a sediment is formed which is used for the purpose desired. Before this sediment forms, the liquid is comparatively clear, and is of the nature of common salt. Now, when the goods are subjected to this solution, the fibers are more or less encrusted in this precipitate, which adds greatly to the weight. The weight is brought about, not only by adding the substance itself, but from the fact that it enables the fiber to absorb and hold a large portion of

moisture. Common salt in itself has this effect. In the first place, if it can be so manipulated as to form an unnoticeable deposit in the fibers of the cloth, it increases the weight in two different ways. One way is by its own inherent weight; the goods will weigh just as much heavier than they should by the amount of salt used. But another way which this adds to the weight lies in the fact that the salt absorbs moisture, and this added weight of moisture which the fibers are enabled to carry serves to increase the weight of the goods to a very considerable extent."

An increase of one-tenth of the weight may be given to the raw fiber before spinning by the use of a mixture of fuller's earth and a solution of soda; this unites with the oil to form an insoluble soap diffused over the fiber, which also attracts moisture, thus increasing the weight.

"In the finishing of woollen fabrics some of the agents which are employed, such as glue, starch, gelatine, albumen, and silicate of soda, are often attended with some kinds of good results, but at the same time, if they are not correctly handled and carefully employed, they must certainly bring about this fraudulent increase in weight, which every careful finisher should try hard to avoid. For really adding to the weight of the goods in the finishing department, china clay and a solution of carbon and wax are often employed.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Technical Journals—See Introductory.

*692. The Canadian Lumber Industry. Ill. J. S. Robertson (Its importance, vast extent and development). Eng Mag–Oct. 3500 w.

708. Fraudulent Weights. Randolph (Materials added to cotton and woolen textures to increase weight). Bos Jour Com–Aug. 10. 1200 w.

*709. The Maxim Flying Machine Ill. A. G. Greenhill (A visit paid to the machine, with description). Nature–Aug. 1. 2000 w.

728. The Contamination of Ice (Ice harvested from rivers and lakes may contain dangerous impurities. Editorial). Eng Rec–Aug 10. 700 w.

744. The Fixation of Atmospheric Nitrogen and the Manufacture of Cyanides and Ammonia. Francis Wyatt (Laboratory methods theoretically considered). Eng & Min Jour–Aug. 10. 2800 w.

750. Commercial Products Resulting from Acetylene. A New Use for the Electric Furnace. R. R. Duncan (We may expect to see the influence of acetylene ramifying throughout all organic chemistry). Elec Eng–Aug. 14. 700 w.

768.—75 cts. Composition of the Sulphur Petroleums of Ohio and Canada. Charles F. Mabery (Chemical analysis and its importance). Tech Quar–April. 6800 w.

770.—75 cts. Further Experiments for Determining the Feasibility of Fire-Clays. Ill. H. O. Hofman. Tech Quar–April. 3300 w.

†785. The Spectroscope in Recent Chemistry. R. A. Gregory (What it reveals bearing upon the alleged identity of the element helium, obtained from cleveite, and the substance represented by the helium line in the solar spectrum). Fortnightly Rev–Aug. 5000 w.

†786. Professor Huxley. I. Some Personal Characteristics. G. C. Brodrick. II. As Anthropologist. E. B. Tylor. III. As Biologist. A Student of Science. IV. As Philosopher. W. L. Courtney. Fortnightly Rev–Aug. 6500 w.

789. Photographic Printing by Machinery. Ill. (Descriptive). Sci Am–Aug 17. 1600 w.

790. Experimental Psychology. E. B. Titchener (Methods of work explained). Sci Am Sup–Aug. 17. 5500 w.

792. The Disposition of the Louisiana Molasses Crop. W. C. Stubbs (A paper read before the La. Sugar Planters' Asso. and printed in La. Planter). Sci Am Sup–Aug. 17. 3300 w.

793. Cheap Ocean Transportation. Ill. The Robertson cigar-shaped raft, for the transportation of lumber). Min & Sci Pr–Aug. 10. 1500 w.

*814. The Scotch Shale-Oil Industry. (Descriptive). Engng–Aug. 9. 800 w.

*817. Military and Civil Works in India. Emeritus (A popular description portraying peculiarities of population, effects of public works, wages and other interesting particulars). Engng–Aug. 9. 5000 w.

*819. A Chief Use of Sanitary Congresses. Editorial (The chief use of these congresses is considered to be the education of the public at large in matters pertaining to sanitary science and engineering). San Rec–Aug. 9. 800 w.

826. Training Our Firemen (Account of the drill exercises at the New York training school). Fire & Water–Aug. 17. 600 w.

834. Richard M. Hunt (Sketch taken from the N. Y. Tribune). Am Arch–Aug. 17. 1300 w.

*843. A German Ironmonger's Business (Descriptive). Irm–Aug. 10. 1900 w.

*847. The Eruption of Vesuvius, July 3. 1895. Ill. H. J. Johnston-Lavis (Descriptive). Nature–Aug. 8. 1700 w.

*859. The Transport of Petroleum (Editorial

We supply copies of these articles. See introductory.

review of improvement of transport facilities). Eng, Lond-Aug. 9. 2500 w.

890. Respiration, Suffocation and Resuscitation. J. Mount Bleyer (The main physiological factors which play the rôle in respiration, suffocation and resuscitation, and the author's method of pneumatic artificial respiration). Elec Rev-Aug. 21. Serial. 1st part. 2500 w.

908. Manufacture of Glue and Sizing. Ill. (Description of processes and appliances). Sci Am-Aug. 24. 1000 w.

*936. The Meerschaum Mines of Anatolia (Interesting general description). Jour Soc of Arts-Aug. 16. 500 w.

*941. Unsanitary Schools and Public Indifference. Douglas H. Stewart (A comprehensive criticism of the neglect of proper sanitary methods in the schools of New York City, which by extension can be made to arraign similar neglect in the majority of the schools in the cities and towns of the United States). Forum-Sept. 4400 w.

*942. Methods and Difficulties of Child-Study. Mrs. Annie Howes Barus (An examination into the utility of a close study of child-life as bearing upon progress in the sciences of psychology, pedagogy and anthropology). Forum-Sept. 3800 w.

952. The Production of Cyanides. H. N. Warren (Method of production and salts used). Am Mfr & Ir Wld-Aug. 23. 400 w.

*959 The Resources and Industries of Birmingham (An interesting account of the various industries and commerce of the great city —written in popular style). Ir & Coal Tr Rev-Aug. 16. 10,000 w.

967. Working Petroleum in Lower Alsace (Methods and appliances. The Alsace petroleum industry dates back to 1742). Am Gas Lgt Jour-Aug. 26. 1400 w.

*973. The Arts and Industries of Venice P. Molmenti (Written in popular style and describing some industries for which Venice has long been famous). Chau-Sept. 4000 w.

983. The Curve of Least Resistance in Water and in Air. Meety Moulton (Results of experiments on ice in water, and wax in hot air). Ry Rev-Aug. 24. 500 w.

984. Interstitial Space (Experiments made to determine the space between particles of emery). Ry Rev-Aug. 24. 1200 w.

986. The Relationships and Responsibilities of Museums. G. Brown Goode (The object of the paper is to begin the codification of the accepted principles of museum administration; and to set forth the aims and ambitions of modern museum practice). Sci-Aug. 23. 6500 w.

987. The Processes of Life Revealed by the Microscope. A Plea for Physiological Histology. Simon Henry Gage. Sci-Aug. 23. 6000 w.

*998 Weather Fallacies (An address to the Royal Meteorological Society by Wm. Richard Inwards). Nature-Aug. 15. 6400 w.

†1030. The Relations of the Diurnal Rise and Fall of the Wind in the United States. Frank Waldo. Am Jour of Sci-Sept. 1600 w.

1037. Fascination by Snakes. Harold S. Ferguson (The author concludes that the snake does not hypnotize, but that the subject is self-mesmerized). Sci Am-Aug. 31. 1000 w.

1049. The Splash of a Drop and Allied Phenomena. Ill. A. M. Worthington (Abstract from a paper read before the Royal Inst. Examples of the successive forms of splashes as revealed by instantaneous photographs). Sci Am Sup-Aug. 31. 2700 w.

†1072. Trades and Faces. Dr. Louis Robinson in Blackwood's Magazine (Discussion and general principles). Pop Sci M-Sept. 7500 w.

†1073. Natural Rain-Makers. Ill. Alexander McAdie (The efficiency of clouds, etc). Pop Sci M-Sept. 2000 w.

†1074. Only a Match. C. Falkenhorst (Historical; interesting). Pop Sci M-Sept. 3000 w.

*1133. A Scheme of Color Standards. J. H. Pillsbury (Identification of colors by their wave lengths, together with an analysis of a number of colo s). Nature-Aug. 22. 4800 w.

*1134. Evidence of the Twilight Arc upon the Planet Mars (Calculations and results in measuring the diameters of Mars). Percival Lowell. Nature-Aug. 22. 4800 w.

†1143. Rainfall and Typhoid Fever. William P. Mason (A paper bringing out the relation, along with statistics, especially in Michigan). Jour Fr Inst-Sept. 1900 w.

*1151. Elasticity of the Wing (Action of a bird's wing on air with relation to flying machines). Am Eng & R R Jour-Sept. 1200 w.

*1152. A Lilienthal Flying Machine. Ill. (A dimensioned drawing with two views of the machine, and results of experiments leading to its development). Am Eng & R R Jour-Sept. 200 w.

*1167. Coffee Growing in Peru (Descriptive). From the South American Journal. Bd of Tr Journal-Aug. 1000 w.

*1178. The Value of Weather Forecasts to Agriculture and Inland Commerce. Mark W. Harrington (The requirements, difficulties and needs; the benefits of the forecasts to various industries). Rev of Rev-Sept. 2200 w.

1193. The Clay Industry of the United States (From the statistics in the report of the Geological Survey). Arch & Build-Aug. 31. 2700 w.

†1221. Cements (Remarks upon various adhesive cements). Ind & East Eng-Aug. 3. 1100 w.

1262. The New Incandescent Light (A competitor to the Welsbach Incandescent Gas Lamp). Am Mfr & Ir Wld-Sept. 6. 300 w.

1269. The Future Supply of India-Rubber (Editorial. Adversely discusses the advisability of the systematic planting of rubber trees). Engng-Aug. 30. 1100 w.

1286. The Relations of the Industries to the Advancement of Chemical Science. William McMurtrie (An address before the Am. Asso. for the Adv. of Science). Science-Sept. 6. 8000 w.

COMMENT & CRITICISM

The Engineering Magazine Index.

I enclose P. O. Order for my subscription to your Magazine.

In this day of exuberant literary production there is felt to be an ever-growing need of such a publication. So much is being written on every subject, and it is so scattered, that it is impossible to keep one's self posted on the literature even of one's special subjects, except with the help of just such a systematic guide as is furnished by your Magazine Index. Might I suggest something, however? Suppose the technical index matter to be printed on thin paper and on one side only. Then those keeping card catalogues could extract the pages, gum the blank sides, let them dry, cut up with scissors, and, by damping, mount each item on a card which would thus fit in with other references, already accumulated, and would also have the advantage of enabling each one to classify and select according to his special needs, and also to alter his classification as his needs changed.

With all good wishes for the continued success of your useful Magazine.

ELFRIC DREW INGALL.

Office Geological Survey, Ottawa, Canada, Sept., 1895.

[Mr. Ingall's suggestion is a very proper one. There can be no doubt that a considerable number of persons in the habit of keeping card indexes would be greatly benefited by the publication of our index in the form which he indicates. From the standpoint of a publisher, however, the idea is impracticable, because of the limited number of persons who would pay for such a publication. It has been estimated by those who are competent to judge, that it would be almost impossible to secure more than one hundred regular subscribers for a publication of this kind. The number of persons who keep card indexes is very limited; very few of them are kept upon the same system; and among those who keep them very few would be influenced to subscribe to a publication by reason of the fact that it would be used as Mr. Ingall suggests. In short, it is a most excellent idea for a few who could make such good use of it, but the publication in that form is impracticable because of the enormous cost in excess of any possible income from it.—THE EDITOR.]

An Error Corrected.

Is there not an error in 9th line from bottom of p. 683 of your July issue? "100,000 men, who receive $1,500,000 per year"—I did not read the article carefully but this statement caught my eye while glancing through it, and in hurriedly examining other statistics they failed to harmonize.

G. D. COLTON.

Collinsville, Conn., Aug., 1895.

There is a manifest error in the figures mentioned by Mr. Colton in my article of July. It should read: "To do this rebuilding and repairing requires 100,000 men who receive $50,000,000 per year and though generally, etc." The census of 1894 gives the number of men and women employed at 110,619, and the wages paid as $63,232,052 which would seem to verify my figures fairly well.

I am glad to be corrected by Mr. Colton, but the error is very evident, as it gives an average wage to each man of but five cents per day of 300 days to the year.

Very truly yours,

JOHN C. WAIT.

Norwich, N. Y., Aug., 1895.

Topical Index. Wood Stave Pipe.

I NOTE that you republish in Aug. number my letter referring to Index of Hydraulic Engineering.

Permit me to say that the topical index mentioned has been through a revision, and now covers 72 pp. of type-written

foolscap; large additions have also been made to the card index.

I can corroborate the testimony on page 1003, August number, as to use of Wood Stave Pipe. It has been used here by the Collins Co. for 40 years or more, in sizes up to 5 or 6 ft. dia. for conducting water to turbine wheels. G. D. COLTON.

Collinsville, Conn., Aug., 1895.

Plans for Home Grounds.

IN the August number of THE ENGINEERING MAGAZINE, in the department of *Domestic Engineering*, I notice an interesting article on "Plans for Home Grounds." To my mind the difficulty in perfecting such plans lies not so much with the plan itself as with the place selected for its execution. You assuredly cannot have a fine lawn, good scenery, and woods where these things do not exist, even in a primitive state. Extensive travel has shown me that the best places to build homes, with a view to good grounds about them, is, in most of the states, about the great lakes, at least in Wisconsin, Michigan, Indiana, and northwestern New York. In the west, I think Iowa is first as regards this matter, but the hills mar, in some regions—especially in central Iowa—what would otherwise be ideal places for home and grounds. T. P. C.

Council Bluffs, Iowa, Sept. 1, 1895.

Mining Under the Sea.

IN addition to the cases of mining under the sea referred to in THE ENGINEERING MAGAZINE for June, there is one at Lota and Coronel on the coast of Chili. There the sea is shallow and the coal does not lie deep. The shafts are on shore, and the coal is lightered out to vessels.

A few years ago a valuable property in the bay of Coronel was ruined by working too near the surface, contrary to the advice of men whose judgment should have been respected. Fortunately the men were not in the mine when the sea broke in—with such force that the roar of the rushing water was heard miles away.

O. F. WHITFORD.

Buffalo, Sept., 1895.

[Besides the project for mining coal under Sydney harbor, N. S. W., above referred to, and the Chilian case cited by our correspondent, several other examples of mining under water might be quoted, as some of the Cornish tin and copper mines, English coal mines, the Silver Islet silver mine in Lake Superior (the most remarkable of all), and the explorations for iron ore under Lake Angeline, Michigan. Grappling for iron ore in Scandinavian lakes, dredging for gold under the sea and in river beds, and dredging for phosphates in South Carolina are also somewhat related cases.—EDITOR.]

Heating Feed Water for Marine Boilers.

NEARLY two years ago I read in THE ENGINEERING MAGAZINE that there was a great need of a device for heating feed water for marine boilers. I investigated and found that marine boiler builders very much desired something for that purpose. I devised a system for taking water from the bottom of a boiler, heating it, and delivering it back to the boiler with the feed water. On consulting with a marine engineer of large experience, he said that a boiler should be strong enough to withstand strains without injury, and the colder the bottom of the boiler the better for the ship's timbers. I agreed with him and dropped the matter. *The Railway Master Mechanic*, for July, published extracts from the reports of committees and the discussions at the R. W. M. M. convention, which developed the fact that there was trouble from bulged fire box sheets and a great diversity of opinion as to the cause. It soon occurred to me that I had scalded my hands as a result of this condition, when searching for something else.

When water containing lime, magnesia, soda, &c., has been used some time in a boiler for making steam (unless the boiler be blown down and replenished often), it accumulates salts in solution, elevating the boiling temperature. If some of this wa- is heated to boiling in a glass flask and water added there will be a flash of steam.

Why water holding a large amount of salts in solution should suddenly evaporate to steam a part of the feed water in-

stead of the feed water instantly reducing the temperature of the water to which it is added I cannot say, but *it does*, and the only sure remedy is hot feed water.

F. A. BUNNELL.

Syracuse, N. Y., Aug., 1895.

BOOKS RECEIVED.

More than Two Thousand Questions Relating to Steam Engineering which every Engineer Should be able to Answer; Systematically Arranged for the Practical Tradesman to Facilitate the Acquiring of Knowledge Needed by Giving Chance for Self-Study; with Argued Answers and over 500 Illustrations. By E. Spangenberg, C. E. Volume I. Laborers' Instruction Publication Co., St. Louis, Mo., 1895. (192 pp., 3″¼×4¾″. Cloth, price 75 cts.")

Arithmetic and Algebra, Plain and Solid Geometry Explained to the Practical Tradesman. By E. Spangenberg, C. E. Volume I. Laborers' Instruction Publication Co., St. Louis, Mo., 1895. (197 pp, 3¼″×4¾″. Cloth, price, 75 cts.)

Eighth Annual Report of the Board of Public Works, City of Duluth, Minn., for the year ending Feb. 28th, 1895. Press of J. J. Le Tournean & Co., Duluth, Minn. (Pamphlet, 57 pp., 6″×9″.)

Michigan Mining School, Houghton, Mich. Prospectus of Elective Studies, May, 1895. Published by the Mining School, Houghton, Mich. (Pamphlet, 50 pp., 5″×7¾″.)

Brick Pavements. By W. W. Wallace, Jr., Willoughby, Ohio. (61 pp., 4″ × 6″. Cloth, price, 50 cts.)

Ninth Biennial Report of the Board of Directors of the Kansas State Historical Society, for the period commencing Nov. 16th, 1892, and ending Nov. 20th, 1894. Also Proceedings of the Meeting, 1895. Topeka Press of the Hamilton Printing Co., 1895. (Pamphlet, 174 pp., 6″×9″.)

Bulletin No. 2, United States Department of Agriculture. Section of Foreign Markets, under the immediate supervision of the Secretary of Agriculture. The World's Markets for American Products. The German Empire. Washington Government Printing Office, 1895. (Pamphlet, 91 pp., 6″×9″.)

City of Boston. Department of Parks. Twentieth Annual Report of the Board of Commissioners for the year ending Jan. 31st, 1895. Printed for the Department, 1895. (Pamphlet, 119 pp., 6″×9″.)

Bridge Deflections. By Malverd A. Howe, Member of the Engineers' Club of St. Louis. Read May 15th, 1895, and reprinted from the Journal of the Association of Engineering Societies, Vol. XIII, No. 6, June, 1895. (Pamphlet, 20 pp., 6″ × 9″.)

Annual Report of the City Engineer of the city of Providence for the year 1894. The Providence Press, 1895. (Pamphlet, 91 pp., 6″ × 9″ with a number of folding insets.)

Atlantic Crosswise Canal Across New Jersey. Report of the canal commissioner of Philadelphia as transmitted to the select and common councils of the city of Philadelphia in accordance with the provisions of city ordinance, Approved July 2d, 1894-1895. (Pamphlet, 54 pp., 9″ × 6″.)

Bulletin No. 3, United States Department of Agriculture, Section of Foreign Markets (under the immediate supervision of the secretary of Agriculture). The World's Markets for American Products. France. Washington Government Printing Office. Pamphlet, 74 pp., 6″ × 9″.)

Sanitary Engineering. By William Paul Gerhard, C. E., Consulting engineer for sanitary works, member American Public Health Association, etc., etc. Reprinted from the Journal of the Franklin Institute, July-August, 1895. Philadelphia, 1895. (Pamphlet, 48 pp., 6″ × 9″.)

The Work of the Sanitary Engineer in Time of Epidemics, in Time of War, and in Sudden Calamities in Civic Life. By William Paul Gerhard, C. E., Consulting engineer for sanitary Works, Member American Public Health Association, etc., etc. Reprinted from the Sanitarium for June, 1895. New York: Burr Printing House, 18 Jacob Street, 1895. (Pamphlet, 14 pp., 6″ × 9″.)

Annual Report of the Commissioner of Civil Works for the Year 1894. Made to the common council of the city of Brooklyn, Feb. 1st, 1895. (283 pp., 6″ × 9″.)

Annual Report of the City Engineer of Toronto for 1894. Toronto: The Carswell Co., Ltd., City Printers, 1895. (Pamphlet, 174 pp., 7″ × 10″.)

Department of the Interior—United States Geological Survey. Charles G. Walcott, Director. The Stone Industry in 1894. By William C. Day. Extracts from the 16th Annual Report of the Director, 1894-1895. Part IV—Mineral Resources of the United States. Calendar Year 1894. Washington Government Printing Office, 1895. (Pamphlet, 83 pp., 7¾″ × 11½″.)

Department of the Interior—United States Geological Survey. Charles G. Walcott, Director. The Production of Tin in Various Parts of the World. By Charles M. Rolker. Extracts from the 16th. annual report of the director, 1894-1895. Part III—Mineral Resources of the United States. Calendar Year 1894. Washington Government Printing Office, 1895. (Pamphlet, 88 pp., 7¾″×11½″.)

14th Annual Report of the United States Geological Survey to the Secretary of the Interior, 1892-1893. By J. W. Powell, Director. Part I, Report of the Director. (321 pp., 7¾″× 11½″.) Part II, Accompanying Papers. (Cloth, 597 pp., 7¾″×11½″, with pocket inside cover containing three maps, 18″×28″.)

Department of the Interior. Census Office. Robert T. Porter, Superintendent; Carroll B.

Wright, commissioner of labor in charge. Report on Population of the United States at the 11th Census, 1890. Part I. Washington, D. C. Government Printing Office, 1895. (Cloth, 968 pp., 9″×11½″.)

Department of the Interior. Monographs of the United States Geological Survey. Volume XIII. Raphael Pumpelly, J. E. Wolff, and T. Nelson Dale. Geology of the Green Mountains in Massachusetts. (Cloth, 206 pp., 9″×11½″.) Volume XIV. Robert Parr Whitfield. Molusca and Crustacea of the Miocene of New Jersey. Washington Government Printing Office, 1894. (Cloth, 195 pp., 9×11½.)

Department of the Interior. Bulletins of the United States Geological Survey. No. 118—A Geographic Dictionary of New Jersey. By Henry Gannett. (Paper, 131 pp., 6″×9″.) No. 119—A Geological Reconnaissance in Northwest Wyoming. By George Homans Eldridge. (Paper, 72 pp., 9″×6″.) No. 120,—The Devonian System of Eastern Pennsylvania and New York. Charles S. Prosser. (81 pp., 6″×9″.) No 121,—The Bibliography of North American Paleontology, 1888–1892. By Charles Rollin Keyes. (251 pp., 6″×9″.) No. 122,—Results of Primary Triangulation. By Henry Gannett. (401 pp., 6″×9″.)

NEW TRADE CATALOGUES.

The Edward P. Allis Co., Milwaukee, Wis., U. S. A.=Catalogue, 120 pp., 6″×9″. [Illustrates and describes mining, milling, and smelting machinery, and also the Reynolds-Corliss engines manufactured by this company. This is an important and valuable catalogue, containing much general as well as special information relating to the lines of machinery named.]

Theodore Alteneder & Sons, Philadelphia, Pa., U. S. A.=Catalogue. III pp., 6″×9″. [Describing and illustrating a line of drawing instruments, well indexed for reference, and also containing price-list. This catalogue will be sent to any applicant on receipt of 4 cents in stamps for postage.]

The Brownell Car Co., St. Louis, Mo., U. S. A.=Catalogue, 172 pp., 9″×6½″, bound in stiff covers. [An elegantly-printed and beautifully-illustrated publication, entitled: "How a Good Car Differs from a Poor One, and How to Get it." The work is practically a treatise on car construction, as well as a description of the cars manufactured by this company.]

Central Railroad Club. Proceedings of the March meeting, 1895, held at the Hotel Iroquois, Buffalo, New York. Reports: Proposed constitution and by-laws. Changes recommended in the rules of interchange. Discussion: Car Doors and Car Door Fixtures. [45 pp., 6″×9″, paper.]

Elementary Machine Design by Albert W. Smith, professor of mechanical engineering in the Leland Stanford, Jr., University, California. Stanford University Press. [163 pp., 6″×7¾″+60 pp. of cuts, flexible canvas cover, price $1.75.]

New York Central Iron Works Co., Geneva, N. Y., U. S. A.=Descriptive catalogue and price list, 19 pp, 9″ × 6″. (1.) [Describing the "Dunning" hot-water heater for warming stores, schools, churches, convents, conservatories, and all classes of buildings by the gravity system of hot-water circulation.] (2) Descriptive catalogue and price list, 55 pp., 10″ × 7″. [Describing and illustrating the Dunning brick-set and portable self-feed and magazine boiler, surface-burning boiler, soft-coal boiler, base-burning boiler, and sectional boiler, with numerous illustrations and table of capacities and sizes; also describing a line of boilers and stationary engines for power purposes; also containing an illustrated description of Denny's Imperial Gas machine, designed for supplying residences, hotels, stores, mill buildings, or groups of buildings, with a safe and cheap illuminating gas.]

Ransome Subway Co., Chicago, Ill., U. S. A. = Pamphlet, 24 pp., 9″ × 6″. [Describes and illustrates monolithic subway sewers, electric conduits, drains, cable and electric railroads, ditches, water pipes, tunnels, etc., constructed under the "Ransome" system, in which the cement pipe or ditch is formed directly in the ground where needed, without bricks or joints.

B F. Sturtevant Co., Boston, Mass., U. S. A.=Pamphlet, 76 pp., 7″ × 9½″. "The Ventilation and Heating of School Buildings" [being a lesson on the necessity of good ventilation, together with a few illustrations to emphasize the same, and a list of school buildings to point the moral. Probably no handsomer trade publication than this has ever been issued. It is beautifully printed in black and red on cream laid paper, with illustrations of the finest character, and bound in flexible leather covers].

Slatington-Bangor Slate Syndicate, Slatington, Pa., U. S. A.=Manual and descriptive price list for 1895. 23 pp., 3½″ × 5″. [Essay on slate as a roofing material and its advantages, with practical hints on roofing buildings with slate, directions for shipping, and lists of sizes and prices; also clippings from various papers relating to the slate industry and the business of this syndicate.]

A. L. Ide & Son, Springfield, Ill., U. S. A.= Catalogue, 24 pp., 3½″×6″. [Describes and illustrates the "Ideal" engine, with price list of regular sizes kept in stock. Elegantly printed and illustrated.]

Detroit Graphite Manufacturing Co., Detroit, Mich., U. S. A.=Pamphlet, 3⅝″ × 6″. [Describes the "Superior" Graphite paint and states its advantages, with a list of testimonials substantiating the statement.]

Harrisburg Foundry & Machine Works, Harrisburg, Pa., U. S. A.=Pamphlet, 16 pp., 6″ × 3⅝.″ [Contains an illustrated article reprinted from the Boston *Post*, describing an ideal engine room, claimed to be a dream of cleanliness and beauty; also contains illustrations of a line of simple, compound, and direct connected Harrisburg Ide and Ideal engines.]

Brown and Sharp Manufacturing Co., Providence, R. I., U. S. A.=Catalogue and price list, 530 pp., 3⅝″ × 6″. [This catalogue contains a large amount of information of value to all mechanical engineers.]